

---

*Final*

# **Remedial Investigation Report Quanta Resources Superfund Site Operable Unit 1**

Submitted to  
**U.S. Environmental Protection Agency, Region 2**

August 2008

**CH2MHILL**

# Executive Summary

---

## Background

This Remedial Investigation (RI) report for Operable Unit (OU) 1 of the Quanta Resources Superfund Site<sup>1</sup> (the “Site”), located in Edgewater, New Jersey (Figure ES-1), has been prepared in accordance with the requirements of the U.S. Environmental Protection Agency (EPA) Administrative Order on Consent II-Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA)-2003-2012 for the Uplands Area, OU1 (EPA, 2003). The Site is adjacent to the Hudson River, in northeastern New Jersey.

The Site consists of the former Quanta Resources property and any locations to which contamination from the property and former operations have migrated. Surface water and sediment in the Hudson River adjacent to OU1 constitute OU2 and are being investigated and addressed separately, pursuant to an EPA Administrative Order on Consent. The presence of constituents associated with former Site operations has been observed in parts of the following areas, which together make up OU1 (Figure ES-2):

- Block 95, Lot 1 (referred to as the Quanta property)
- Block 91, Lot 1 (referred to as the former Celotex property<sup>2</sup>)
- Block 96, Lot 3.01 (referred to as the 115 River Road property)
- Block 99, Lot 1 (referred to as the former Lever Brothers property)
- River and Gorge roads
- Block 93 (north, central, and south)

The OU1 RI included collection and assessment of a substantial amount of data and information as prescribed in the EPA-approved “OU1 Remedial Investigation/Feasibility Study (RI/FS) Work Plan” (Parsons, 2005) and associated Field Sampling Plan, Health and Safety Plan, and Quality Assurance Project Plan (QAPP); three RI/FS Work Plan addendums; and by additional EPA requests.

The OU1 RI has achieved to a large degree its objective of completing a comprehensive site characterization including:

- Characterization of OU1 sources
- Determination of the nature and extent of contamination
- Evaluation of fate and transport of constituents of interest (COI)
- Assessment of potential risks to human health and the environment

---

<sup>1</sup> As defined in Administrative Order on Consent (AOC) II-CERCLA-2003-2012, the Quanta Resources Superfund Site includes the former Quanta Resources property, located on River Road in Edgewater, New Jersey, and any areas where contamination from the property has come to be located. The current Quanta property refers to Block 95, Lot 1, as defined on the Borough of Edgewater, New Jersey, tax map.

<sup>2</sup> This property may also be referred to as the Edgewater Enterprises property. Edgewater Enterprises, LLC, was a former owner of Block 91, Lot 1. The chain of title is provided in Appendix A.



Additional data gaps were identified during the completion of the OU1 RI, and additional work has been proposed as part of the “Final RI/FS Work Plan Addendum No. 4 for a Supplemental Remedial Investigation (SRI)” (CH2M HILL, 2008a).

This RI report compiles and presents evaluations of the following data:

- Over 3,600 soil analyses
- Data from 57 groundwater monitoring locations
- Extensive non-aqueous phase liquid (NAPL) “fingerprinting” data
- NAPL physical characteristics data
- Ninety-eight probe locations using an innovative fluorescence response technology to delineate coal tar
- Soil vapor and indoor and outdoor air analyses and building surveys

Evaluations of or data from over 30 previous reports and memoranda prepared for properties within or adjacent to OU1 were reviewed and incorporated into the characterization. The Site is well understood for purposes of supporting remedial alternative development, evaluation, and selection. On the basis of this understanding, a conceptual site model was developed for OU1 (Figure ES-3).

The most significant RI conclusions are the following:

- All primary sources have been removed, with the exception of some buried piping on the Quanta property.
- Site-related secondary sources of polycyclic aromatic hydrocarbons (PAHs) and other constituents—including NAPL, pitch, and impacted soil—have been identified and characterized over the majority of OU1.
- The foremost Site-related secondary source of arsenic and lead, and to a lesser extent other metals, within OU1 are the remnants of oxidizing pyrite ore (reddish-purple soils) within the footprint of a former acid plant in the northwest portion of the Quanta property and at the former Celotex property. This source material has been identified and comprehensively characterized.
- An additional non-Site-related secondary source of metals and PAHs at OU1 is ubiquitous heterogeneous fill material, some of which contains slag. This fill material contains metals and PAHs largely unrelated to former operations at OU1.
- Primary COIs include arsenic in soil and groundwater, dissolved phase constituents in groundwater associated with NAPL (e.g., naphthalene) and PAHs in soils.
- NAPL is present in discrete zones above and within the top few feet of a silty clay confining layer. Free-phase NAPL is potentially recoverable but does not appear to be migrating under current conditions, with the possible exception of NAPL in the zones adjacent to the Hudson River. For the purposes of evaluating OU1 and OU2 and developing remedial alternatives, it is conservatively assumed that NAPL migration between OU1 and OU2 is possible. Additional investigation has been proposed in these

areas to determine whether NAPL migration is occurring between OU1 and OU2. Results of this evaluation and an updated conceptual model will be presented in a forthcoming Supplemental RI Report.

- The silty clay confining unit for groundwater with limited thickness is present at the Site. This unit hydraulically separates the shallow, unconfined groundwater (in native soils and fill) from the lower, deeper, confined sand unit.
- Concentrations of constituents in groundwater have generally been steady and decline with distance from sources.
- Arsenic in groundwater is largely a function of oxidation-reduction (redox) and pH conditions, which vary across OU1. Specifically, reducing conditions caused by the presence of NAPL and other naturally occurring sources of organics (e.g., peat deposits) have contributed to the dissolution of arsenic in proximity to some of these sources. As with other constituents in groundwater, arsenic concentrations are generally constant over time and decline with distance from source areas. Arsenic associated with the former acid plant attenuates in groundwater through mineral precipitation and adsorption processes (via redox and pH changes) and does not appear to migrate to the Hudson River. Additional investigation is being performed to address this potential pathway as part of addendum 4 for an SRI (CH2M HILL, 2008a).
- Remediation triggers developed as part of the Baseline Risk Assessment were exceeded in soil and shallow groundwater for at least one assumed future receptor at the five properties evaluated. Surficial tar “boils” identified during the RI will also be addressed during future remedial actions.
- Additional data gaps were identified during the completion of the OU1 RI, and additional work has been proposed as part of addendum 4 for an SRI (CH2M HILL, 2008a), submitted to EPA on July 31, 2008.

Following is a brief summary of the major findings from the RI field investigation and conclusions based on the assessment of data and information collected.

## Sources

Sources of Site-related constituents have been identified and characterized. Coal tar processing and subsequent oil-recycling operations contributed to existing secondary sources of contamination at the Site, including NAPL, pitch, soil impacted with PAHs, and other constituents. A former acid plant on the northern portion of the Quanta property and southern portion of the former Celotex property, contributed to the presence of oxidizing pyrite ore remnants in soil. Primary sources are no longer present, with the possible exception of buried piping on the Quanta property.

Additional secondary sources contributing to soil and groundwater contamination unrelated to former operations (such as regional fill material and former operations on adjacent properties) are present within the extent of OU1. Secondary sources of COIs in groundwater and/or soil unrelated to but within the extent of OU1 include the following:

- Fill material, unrelated to former Site operations, throughout this part of Edgewater

- Identified Areas of Concern related to the former Lever Brothers property (including but not limited to COIs in soil and groundwater associated with light non-aqueous phase liquid [LNAPL], and pitch/asphaltic material in the northern and central portions of this property)
- An upgradient source of chlorinated solvents impacting groundwater within the confined deep sand unit
- Polychlorinated biphenyls (PCBs) in soil at adjacent properties

## NAPL

The location, nature, and extent of most of the NAPL at OU1 have been defined. The current understanding of NAPL location will be supplemented during the implementation of the SRI (CH2M HILL, 2008a). Free-phase and residual NAPL are present at the Site, and samples from monitoring wells have been identified as consisting of coal tar and undifferentiated hydrocarbons. Most free-phase NAPL is present in discrete areas (or zones) above and within the top few feet of the silty clay confining layer. Free-phase NAPL is recoverable but does not appear to be migrating under current conditions, with the possible exception of NAPL within zones adjacent to the Hudson River. The available evidence supports the conclusion that most NAPL in this area is residual. The possibility of migration at this location is based on the presence of NAPL deposits at both OU1 (NZ-2 and NZ-5) and OU2 at similar depths and by the presence of sheens at the shoreline on the former Celotex property. Therefore, for purposes of developing, evaluating, and selecting a remedial alternative, it is conservatively assumed that NAPL migration between OU1 and OU2 is possible. Additional evaluation of this potential migration will be performed as part of the SRI (CH2M HILL, 2008a).

Since most NAPL at OU1 is denser than water, the NAPL has migrated downward by gravity but has been halted by either increasing pore pressure with depth or the silty clay confining layer. The lateral and vertical extents of NAPL at OU1 are generally stable under current conditions. Migration is constrained by either the physical properties of the NAPL (i.e., high viscosity and interfacial tension), the soil pore size, or the presence of physical barriers such as the silty clay confining unit. NAPL identified at depth has been found to accumulate in the natural depressions in the surface of the confining unit owing to gravity and the upward sloping surfaces of the silty clay confining unit to the south and east. NAPL will not migrate laterally under current conditions. The potential for NAPL mobility to be impacted by changes in subsurface conditions is an important consideration for the Site. The effects on NAPL mobility of future development activities such as excavation or placement of fill material, placement of subsurface structures, or pumping of groundwater should be considered when specific development plans have been defined.

Solid tar has been observed in several soil borings at the Site in the form of a black, soft to stiff, semiplastic to plastic material at discrete depth intervals with a thicknesses ranging from 0.3 feet to approximately 6 feet. Three main areas where the solid tar was observed in borings or excavations have been identified: (1) the eastern portion of Block 93 North, (2) the western portion of the Quanta property, and (3) adjacent to the Hudson River on the Quanta property. Surficial tar boils have also been observed within or near the solid tar areas.

## Constituents of Interest

COIs were developed by screening analytical results against the lowest applicable screening criteria of the EPA Region 9 Preliminary Remediation Goals (PRGs), proposed New Jersey soil cleanup criteria, and New Jersey groundwater quality criteria. The primary COIs include arsenic in soil and groundwater and PAHs and aromatic volatile organic compounds (VOCs) associated with NAPL in soil and groundwater (e.g., benzo(a)pyrene, naphthalene, and benzene).

### Organic COIs

Organic COIs in groundwater include SVOCs and VOCs. Some limited detections of chlorinated solvents have also been observed in the deeper confined groundwater; they are likely from an upgradient release. No significant detections of chlorinated solvents have been observed in OU1 soils or in NAPL.

Concentrations of organic constituents in groundwater are generally constant over time and decline with distance from sources. The footprint of the composite extent of COIs in groundwater is not expanding; concentrations of constituents in groundwater are in equilibrium as a result of adsorption and degradation processes. Shallow unconfined groundwater flow is generally towards the east (Hudson River) and south (former Lever Brothers property) at an average flow velocity of approximately 0.55 feet/day. As dissolved phase COIs move from source areas at OU1 adjacent to the Hudson River and upward through the sediments in OU2, they are subjected to further attenuation.

### Inorganic COIs

Inorganic COIs in groundwater include lead, ammonia, and arsenic. The main source of lead is the storage and/or combustion of pyritic ore. Another source of lead in soil and groundwater is the ubiquitous presence of heterogeneous, slag-rich fill material. Elevated levels of lead in soil are present throughout the former Celotex property and are not as abundant elsewhere at the Site. Due to the relative immobility of lead, elevated concentrations do not persist in groundwater downgradient to the south or east of this source. Rather, lead is quickly adsorbed to organics or hydroxide minerals or precipitated.

Soil data, visual observations, and documented mineralogical differences suggest that two sources of arsenic exist within OU1 soils. These two sources include the remnants of oxidizing pyrite ore (reddish-purple soils) within the footprint of a former acid plant and the presence of fill material containing slag throughout OU1 and the surrounding area. The extent of elevated arsenic concentrations in soil associated with the former acid plant have been defined and do not extend beyond the southwestern portion of the Celotex property or northwestern corner of the Quanta property. This material is generally associated with the reddish-purple soils within the footprint of the former acid plant.

Arsenic concentrations in groundwater exceeding regulatory criteria is primarily a function of groundwater pH, redox (e.g., ORP) conditions, and the precipitation of colloidal iron oxyhydroxides, which vary across OU1. Both the oxidation of pyrite and the fill material are sources of arsenic in groundwater across OU1 and at adjacent properties. Concentrations of dissolved arsenic are controlled largely by the precipitation of colloidal iron oxyhydroxides,

which serve as a geochemical sink for arsenic (and other metals).<sup>3</sup> However, arsenic concentrations in groundwater are generally constant over time and decline with distance from secondary source areas.

Arsenic associated with the former acid plant attenuates in groundwater through mineral precipitation and adsorption processes and does not migrate to the Hudson River. However, additional secondary sources of arsenic related to fill material have contributed to arsenic concentrations adjacent to the Hudson River. Arsenic that is not scavenged from groundwater prior to moving from these areas will be subject to further attenuation in OU2 (i.e., oxic river water will precipitate arsenic in a solid phase).

## Risk Assessment

A human health risk assessment (HHRA) was conducted for most of OU1 (with the exception of River and Gorge roads, Block 93 Central, and Block 93 South), and has identified constituents of concern (COCs) for three media:

- Surface soil (0–2 feet below ground surface [bgs])
- Subsurface soil (0–10 feet bgs)
- Groundwater (above and below the clay layer)

Current potential receptors identified in the HHRA include trespassers, commercial workers, and daycare children. For potential future land use, receptors include construction and utility workers, commercial workers, daycare children, trespassers, and residents. Risks above acceptable levels for one or more current or future receptors as a result of exposure to either soil or groundwater were calculated for the Quanta, former Celotex, 115 River Road, former Lever Brothers, and Block 93 North properties. The primary risk drivers at the Site are carcinogenic PAHs, naphthalene, and arsenic. Along with these primary risk drivers, surficial tar boils identified during the RI will be addressed during future remedial actions.

Studies of potential vapor intrusion pathways have been conducted at buildings at 115 River Road, Block 93 North (former Jono's Restaurant), and the former Lever Brothers property (Building 9). These studies have included groundwater and subslab and indoor air sampling, physical observations of the buildings, and measurements of air pressure within buildings. The results from these studies conclude that the vapor intrusion pathways are unlikely to be present or have been determined not to pose an unacceptable human health risk to the occupants of these buildings under current conditions. A Screening-Level Ecological Risk Assessment (SLERA) completed for OU1 evaluated potential risk to terrestrial receptors from exposure to compounds detected in surface soil on the 5.5-acre Quanta property. Potential ecological risk was evaluated through direct exposure to soil and via the food chain exposure pathway. Using conservative exposure scenarios and assumptions, risk was indicated to plant and invertebrate receptors via direct exposure and to higher-order receptors exposed to contamination through the food chain. The SLERA was refined using less-conservative assumptions, which reduced the number of compounds indicating potential risk from direct exposure and limited the higher-order receptors at potential risk to small-mammal species. Based on the location of the Site in an urban area

---

<sup>3</sup> Colloidal iron oxyhydroxides rich in arsenic typically pass thru 0.45-µm filters or are present in nonfiltered groundwater samples, and when the sample is acidified for method preservation purposes, releases arsenic into the sampled groundwater, thereby biasing the groundwater sample high.

with limited and poor quality habitat available for receptor populations, it is unlikely that these receptors inhabit OU1. In their July 7, 2006, comments on the SLERA, EPA agreed with the overall conclusion that additional characterization of ecological risk at OU1 was not necessary.

## Conclusions and Next Steps

The Site has been characterized and is well understood for purposes of supporting OU1 remedial alternative development, evaluation, and selection. The extent of OU1 contamination for groundwater, soil, and NAPL based on the data and evaluations presented in the RI is shown in Figure ES-4.

Additional work has been proposed as part of the SRI (CH2M HILL, 2008a) to address the data gaps noted. The results of this investigation will be presented in a Supplemental RI Report for OU1 that will serve to update the applicable components of this Final RI, address the remaining agency comments, and complete the RI process for the Site.

The next step will be to complete the development and evaluation of OU1 remedial alternatives, which will be documented in the OU1 Feasibility Study (FS) Report. Based on the RI findings, the FS for OU1 will evaluate technologies and develop and screen remedial alternatives to

- Reduce current and/or potential future human health risks to acceptable levels at the properties comprising OU1, including limiting potential future contact with NAPL
- Prevent erosion, transport, or migration of COCs in soil or groundwater offsite or to OU2 at concentrations resulting in human or ecological risk above acceptable levels

# Contents

---

<b>Executive Summary.....</b>	<b>iii</b>
<b>Abbreviations and Acronyms .....</b>	<b>xix</b>
<b>1 Introduction .....</b>	<b>1-1</b>
1.1 Original RI/FS Work Plan .....	1-2
1.2 RI/FS Work Plan Addendum No. 1 .....	1-3
1.3 RI/FS Work Plan Addendum Nos. 2 and 4 .....	1-4
1.4 RI/FS Work Plan Addendum No. 3 .....	1-4
1.5 Definitions .....	1-6
1.6 Purpose .....	1-6
1.7 Report Organization .....	1-7
1.8 Site Background .....	1-8
1.8.1 Operable Unit 1 Description .....	1-8
1.8.2 Site History .....	1-8
1.8.3 Previous Investigations .....	1-12
1.8.4 Background Conditions .....	1-20
<b>2 Investigation Summary .....</b>	<b>2-1</b>
2.1 Data Quality Objectives .....	2-1
2.1.1 RI/FS Work Plan .....	2-1
2.1.2 RI/FS Work Plan Addendum .....	2-1
2.1.3 RI/FS Work Plan Addendum Nos. 2 and 4 .....	2-2
2.1.4 RI/FS Work Plan Addendum No. 3 .....	2-3
2.1.5 Other Activities .....	2-3
2.2 Site Surveying .....	2-5
2.2.1 Site Survey .....	2-5
2.2.2 Subsurface Utility Survey .....	2-6
2.2.3 Floodplain Delineation .....	2-6
2.2.4 Cultural Resources Survey .....	2-7
2.3 Investigation Procedures .....	2-8
2.3.1 Boring Advancement .....	2-9
2.3.2 Soil Sampling .....	2-10
2.3.3 Permanent Monitoring Well Installation and Sampling .....	2-12
2.3.4 Temporary Well Point Installation and Sampling .....	2-16
2.3.5 Hydraulic Conductivity Testing .....	2-17
2.3.6 Potential Preferential Pathway Assessment .....	2-17
2.3.7 Tidal Study .....	2-18
2.3.8 Synoptic Water Level and NAPL Measurements .....	2-19
2.3.9 NAPL Sampling .....	2-20
2.3.10 TarGOST® Investigation .....	2-21
2.3.11 Vapor Intrusion Evaluations .....	2-23
2.3.12 Seasonal Standing Water Sampling .....	2-28
2.3.13 NAPL Recovery Testing .....	2-28

2.3.14	Arsenic Dust Evaluation.....	2-30
2.4	Field Equipment Decontamination.....	2-30
2.5	Management of Investigation-Derived Waste .....	2-31
2.6	Database Management, Data Validation, and Data Evaluation .....	2-31
<b>3</b>	<b>Site Characteristics.....</b>	<b>3-1</b>
3.1	Surface Features.....	3-1
3.1.1	Quanta Property .....	3-1
3.1.2	Former Celotex Property .....	3-2
3.1.3	115 River Road Property .....	3-2
3.1.4	Former Lever Brothers Property .....	3-2
3.1.5	Block 93 North Property .....	3-3
3.1.6	Block 93 Central Property .....	3-3
3.1.7	Block 93 South Property .....	3-3
3.2	Geology .....	3-4
3.3	Hydrogeology .....	3-6
3.3.1	Groundwater Flow Directions.....	3-7
3.3.2	Hydraulic Conductivity Testing Results.....	3-9
3.3.3	Tidal Study Results .....	3-10
3.4	Demography and Land Use.....	3-10
3.4.1	Demography .....	3-10
3.4.2	Land Use .....	3-11
3.5	Cultural Resources .....	3-11
3.6	Ecology.....	3-12
3.6.1	Habitat.....	3-12
3.6.2	Biota.....	3-13
3.6.3	Threatened and Endangered Species.....	3-13
<b>4</b>	<b>Nature and Extent of Contamination .....</b>	<b>4-1</b>
4.1	Sources of Contamination .....	4-1
4.1.1	Non-Aqueous Phase Liquid.....	4-2
4.1.2	Solid Tar and Tar “Boils” .....	4-12
4.1.3	Former Acid Plant .....	4-13
4.1.4	Fill Material .....	4-17
4.1.5	Additional Sources.....	4-19
4.2	Constituents of Interest.....	4-22
4.2.1	Soil COIs .....	4-22
4.2.2	Groundwater COIs.....	4-23
4.3	Soil .....	4-23
4.3.1	Polycyclic Aromatic Hydrocarbons.....	4-23
4.3.2	Semivolatile Organic Compounds.....	4-26
4.3.3	Volatile Organic Compounds .....	4-27
4.3.4	Inorganic Constituents.....	4-29
4.3.5	Pesticides .....	4-35
4.3.6	Polychlorinated Biphenyls .....	4-36
4.4	Groundwater.....	4-36
4.4.1	Polycyclic Aromatic Hydrocarbons.....	4-36
4.4.2	Semivolatile Organic Compounds.....	4-39
4.4.3	Volatile Organic Compounds .....	4-40



4.4.4	Inorganic Constituents .....	4-42
4.4.5	Pesticides .....	4-46
4.4.6	Polychlorinated Biphenyls .....	4-46
4.5	Preferential Pathways Evaluation .....	4-47
4.6	Vapor Intrusion Evaluations .....	4-50
4.6.1	115 River Road Building Complex .....	4-51
4.6.2	Building 9 (Former Lever Brothers Property) .....	4-53
4.6.3	163 Old River Road Building .....	4-54
4.7	Extent of OU1 .....	4-57
4.7.1	Horizontal Extent of OU1 .....	4-57
4.7.2	Vertical Extent of OU1 .....	4-58
<b>5</b>	<b>Fate and Transport .....</b>	<b>5-1</b>
5.1	General Mechanisms of Fate and Transport .....	5-1
5.1.1	Aqueous Solubility .....	5-1
5.1.2	Advection .....	5-2
5.1.3	Sorption .....	5-2
5.1.4	Leaching .....	5-6
5.1.5	Volatilization .....	5-6
5.1.6	Erosion .....	5-7
5.1.7	Degradation .....	5-7
5.1.8	Non-Aqueous Phase Liquid Mobility .....	5-9
5.2	Representative COIs .....	5-10
5.2.1	Polycyclic Aromatic Hydrocarbons .....	5-10
5.2.2	Non-PAH SVOCs .....	5-13
5.2.3	Aromatic VOCs .....	5-14
5.2.4	Chlorinated VOCs .....	5-14
5.2.5	Inorganics .....	5-15
5.2.6	Pesticides .....	5-17
5.2.7	Polychlorinated Biphenyls .....	5-17
5.3	Fate and Transport of Non-Aqueous Phase Liquid .....	5-18
5.3.1	NAPL Zone 1 .....	5-19
5.3.2	NAPL Zone 2 .....	5-20
5.3.3	NAPL Zone 3 .....	5-20
5.3.4	NAPL Zone 4 .....	5-21
5.3.5	NAPL Zone 5 .....	5-21
5.3.6	Summary of NAPL Fate and Transport .....	5-21
5.3.7	Tar Boils .....	5-22
5.4	Soil Fate and Transport .....	5-22
5.4.1	Polycyclic Aromatic Hydrocarbons .....	5-23
5.4.2	Non-PAH SVOCs .....	5-24
5.4.3	Aromatic VOCs .....	5-24
5.4.4	Chlorinated VOCs .....	5-24
5.4.5	Metals .....	5-24
5.4.6	Ammonia .....	5-25
5.4.7	Pesticides .....	5-26
5.4.8	Polychlorinated Biphenyls .....	5-26
5.5	Fate and Transport of Groundwater .....	5-26

5.5.1	Semivolatile Organic Compounds .....	5-27
5.5.2	Volatile Organic Compounds .....	5-28
5.5.3	Metals .....	5-30
5.5.4	Ammonia .....	5-40
5.5.5	Pesticides and PCBs .....	5-41
<b>6</b>	<b>Conceptual Site Model.....</b>	<b>6-1</b>
6.1	Current Land Use .....	6-1
6.2	Geology and Hydrogeology .....	6-1
6.3	Primary Sources .....	6-2
6.4	Secondary Sources .....	6-3
6.5	Migration Pathways .....	6-4
6.5.1	Non-Aqueous Phase Liquid Migration .....	6-4
6.5.2	Advection .....	6-4
6.5.3	Partitioning .....	6-5
6.5.4	Abiotic and Biotic Transformations .....	6-6
6.5.5	Erosion .....	6-7
6.6	Potential Pathways and Receptors .....	6-7
6.6.1	Ecological Risk Pathways and Receptors .....	6-7
6.6.2	Human Health Risk Pathways and Receptors .....	6-7
<b>7</b>	<b>Baseline Risk Assessment .....</b>	<b>7-1</b>
7.1	Human Health Risk Evaluation .....	7-1
7.1.1	Hazard Identification .....	7-2
7.1.2	Exposure Assessment .....	7-4
7.1.3	Toxicity Assessment .....	7-4
7.1.4	Risk Characterization .....	7-4
7.1.5	Preliminary Remediation Goals .....	7-6
7.2	Ecological Evaluation .....	7-7
<b>8</b>	<b>Summary and Conclusions.....</b>	<b>8-1</b>
8.1	Site Setting and Background .....	8-1
8.2	Site Geology and Hydrogeology .....	8-1
8.3	Sources .....	8-2
8.4	Nature and Extent .....	8-3
8.4.1	Nature and Extent of NAPL and Solid Tar .....	8-3
8.4.2	Nature and Extent of COIs in Soil .....	8-4
8.4.3	Nature and Extent of COIs in Groundwater .....	8-5
8.4.4	Extent of OU1 .....	8-6
8.5	Fate and Transport .....	8-7
8.5.1	Fate and Transport of NAPL .....	8-7
8.5.2	Fate and Transport of Constituents of Interest in Soil .....	8-8
8.5.3	Fate and Transport of Constituents of Interest in Groundwater .....	8-9
8.6	Risk Assessment .....	8-10
8.7	Recommendations .....	8-11
<b>9</b>	<b>References.....</b>	<b>9-1</b>

## Tables

2-1	Summary of Soil Boring Information
2-2	Soil Sample Analytical Method Summary
2-3	Monitoring Well Construction Summary
2-4	Summary of RI Groundwater and Surface Water Samples
2-5	Summary of Groundwater and Standing Water Quality Field Parameter Results
2-6	Summary of NAPL Samples and Analyses
3-1	Summary of Hydraulic Conductivity Values
3-2	Synoptic Water Levels – High Tide
3-3	Synoptic Water Levels – Low Tide
3-4	Calculated Vertical Hydraulic Gradients
4-1	Summary of NAPL Measurements
4-2	Summary of NAPL Fingerprinting and Physical Parameters
4-3	Correlation of TarGOST® Results with Boring Logs: Evidence for Presence of NAPL at 50 Percent RE
4-4	Cinder/Ash/Coal/Slag and Reddish-Purple Soil Observations and Sampling Summary
4-5	Soil Screening Criteria
4-6	Constituents of Interest in Soil
4-7	Groundwater Parameter Screening Criteria
4-8	Constituents of Interest in Groundwater
4-9	Statistical Comparison of Cinder/Ash Soils and Pyrite Cinder-Impacted Soils
4-10	Groundwater Data Results Summary for Arsenic and Nitrogen Parameters, August/October 2006
5-1	Physical and Chemical Properties of Representative Organic Constituents of Interest
5-2	Retardation Factor Calculations for Select Organic Compounds
5-3	TOC Soil Sample Lithology Summary

## Figures

1-1	Study Area Location Map
1-2	Property Location Map with Aerial Photograph
1-3	Pertinent Historical Features
1-4	Plan View of 115 River Road Buildings
1-5	NJDEP Historic Filling Map
2-1	FEMA Flood Plain Map
2-2	Remedial Investigation Soil Sample Locations
2-3	Remedial Investigation Groundwater Monitoring Locations
2-4	Subsurface Utilities and Potential Preferential Pathways Sampling Locations
2-5	TarGOST® and Confirmatory Boring Location Plan
3-1	Geologic Cross-Section Base Map
3-2	Geologic Cross-Sections A to A' and B to B'
3-3	Geologic Cross-Sections C to C' and D to D'
3-4a	3D Depictions of Site Geology

- 3-4b Elevation Contour Map—Top of Silty Clay
- 3-4c Elevation Contour Map—Top of Bedrock
- 3-5 Water Table Elevation Contour Map, Oct. 16, 2006, Water Table, Mid-Tide
- 3-6 Potentiometric Elevation Contour Map, Oct. 16, 2006, Deep Sand Unit Groundwater
- 3-7 Tidal Study Hydrograph—Shallow Groundwater Monitoring Wells
- 3-8 Tidal Study Hydrograph—Deep Sand Unit Groundwater Monitoring Wells
  
- 4-1 Maximum TarGOST® Response Contouring
- 4-2 Views of 3D Geologic Model with Coal Tar Extents
- 4-3 Cross Sections Showing Coal Tar Distribution Based on TarGOST®
- 4-4 Lateral Extent of NAPL and Coal Tar Impacts
- 4-5 Cinder/ Ash and Reddish-Purple Soils Locations
- 4-6 Historical Maps and Wetlands Filling
- 4-7 Constituents Exceeding Criteria—PAHs in Soil 0–4 feet bgs (3 Sheets)
- 4-8 Constituents Exceeding Criteria—PAHs in Soil >4 feet bgs (4 Sheets)
- 4-9 Soil Isoconcentration Contours—Benzo(a)pyrene (0–4 feet bgs)
- 4-10 Soil Isoconcentration Contours—Benzo(a)pyrene (>4 feet bgs)
- 4-11 Soil Isoconcentration Contours—Naphthalene (0–4 feet bgs)
- 4-12 Soil Isoconcentration Contours—Naphthalene (>4 feet bgs)
- 4-13 Constituents Exceeding Criteria—SVOCs in Soil 0–4 feet bgs
- 4-14 Constituents Exceeding Criteria—SVOCs in Soil >4 feet bgs
- 4-15 Constituents Exceeding Criteria—VOCs in Soil 0–4 feet bgs
- 4-16 Constituents Exceeding Criteria—VOCs in Soil >4 feet bgs
- 4-17 Soil Isoconcentration Contours—Benzene (0–4 feet bgs)
- 4-18 Soil Isoconcentration Contours—Benzene (>4 feet bgs)
- 4-19 Constituents Exceeding Criteria—Inorganics in Soil 0–4 feet bgs (3 sheets)
- 4-20 Constituents Exceeding Criteria—Inorganics in Soil >4 feet bgs (3 sheets)
- 4-21 Soil Isoconcentration Contours—Lead (0–4 feet bgs)
- 4-22 Soil Isoconcentration Contours—Lead (>4 feet bgs)
- 4-23 Soil Isoconcentration Contours—Arsenic (0–4 feet bgs)
- 4-24 Soil Isoconcentration Contours—Arsenic (>4 feet bgs)
- 4-25 Constituents Exceeding Criteria—Pesticides/PCBs in Soil 0–4 feet bgs
- 4-26 Constituents Exceeding Criteria—PCBs in Soil >4 feet bgs
- 4-27 Soil Isoconcentration Contours—PCBs (0–4 feet bgs)
- 4-28 Soil Isoconcentration Contours—PCBs (>4 feet bgs)
- 4-29 Constituents Exceeding Criteria—PAHs in Groundwater
- 4-30 Groundwater Isoconcentration Contours—Benzo(a)pyrene (August 2006)
- 4-31 Groundwater Isoconcentration Contours—Naphthalene (August 2006)
- 4-32 Constituents Exceeding Criteria—SVOCs in Groundwater
- 4-33 Groundwater Isoconcentration Contours—Dibenzofuran (August 2006)
- 4-34 Constituents Exceeding Criteria—VOCs in Groundwater
- 4-35 Groundwater Isoconcentration Contours—Benzene (August 2006)
- 4-36 Constituents Exceeding Criteria—Inorganics in Groundwater
- 4-37 Groundwater Isoconcentration Contours—Lead (August 2006)
- 4-38 Groundwater Isoconcentration Contours—Arsenic (2006/2007)
- 4-39a Groundwater Isoconcentration Contours—Ammonia (August/October 2006)
- 4-39b Extent of Reddish-Purple Soils, Arsenic in Groundwater, and Coal Tar

4-40	Constituents Exceeding Criteria – Pesticides and PCB Aroclors in Groundwater
4-41	Extent of Quanta Resources Superfund Site (OU1)
5-1	Geochemical Parameter Contours – Eh, Shallow Groundwater
5-2	Geochemical Parameter Contours – Eh, Deep Unconfined Groundwater
5-3	Geochemical Parameter Contours – pH, Shallow Groundwater
5-4	Geochemical Parameter Contours – pH, Deep Unconfined Groundwater
5-5	Cross Sections Showing Coal Tar Distribution at OU1 and OU2 Based on TarGOST®
5-6	Groundwater Concentration Contours over Time – Naphthalene
5-7	Groundwater Concentration Contours over Time – Benzene
5-8	Geochemical Zones
5-9	Criteria for Geochemical Descriptions
5-10	Site-Specific Eh vs. pH and Shallow Groundwater Arsenic System
5-11a	Site-Specific Eh vs. pH and Shallow Groundwater Partial Iron System, Dissolved As > 10 mg/L
5-11b	Site-Specific Eh vs. pH and Partial Iron System, Dissolved as 1.0–10.0 mg/L
5-11c	Site-Specific Eh vs. pH and Partial Iron System, Dissolved as 0.1–1.0 mg/L
5-11d	Site-Specific Eh vs. pH and Partial Iron System, Dissolved as ND–0.1 mg/L
5-12	Geologic Cross Sections A to A' and E to E' and Arsenic in Groundwater Isoconcentration Lines
5-13	Geologic Cross Sections F to F' and G to G' and Arsenic in Groundwater Isoconcentration Lines
5-14	Groundwater Isoconcentration Contours Arsenic (Shallow Groundwater)
6-1	Conceptual Site Model for OU1

## Appendices

A	Site History Summary
B	Soil Boring Logs
C	Soil Data Tables
D	Complete Laboratory Reports (DVD)
E	Monitoring Well Completion Diagrams, Form Bs, and Development Logs
F	Groundwater and Standing Water Data Tables
G	Hydraulic Conductivity Testing Data
H	Preferential Pathways Data Tables
I	NAPL Data Tables
J	TARGOST® Technology Information and Data
K	Vapor Intrusion Memoranda (Oct. 6, 2006; Dec. 21, 2006; Jan. 31, 2007; Mar. 28, 2007; Apr. 12, 2007; Jul. 9, 2007; June 20, 2008; and July 25, 2008)
L	Quality Assurance/Quality Control Evaluation
M	Groundwater Potentiometric Contour Maps
N	Supplemental Investigation Technical Memorandum
O	Groundwater Concentration versus Time Plots
P	Human Health Risk Assessment
Q	Ecological Risk Assessment

# Abbreviations and Acronyms

---

pb	soil bulk density
2D	two-dimensional
3D	three-dimensional
ALM	Adult Lead Methodology
amsl	above mean sea level
AOC	Area of Concern
API	American Petroleum Institute
ARAR	applicable or relevant and appropriate requirements
atm-m <sup>3</sup> /M	atmosphere-cubic meter per mole
AST	aboveground storage tank
ASTM	American Society of Testing and Materials
ATSDR	Agency for Toxic Substances and Disease Registry
BABs	branched alkylbenzenes
bgs	below ground surface
BHC	benzene hexachloride
BLL	blood lead level
BN	base neutral
BNA	Base Neutral/ Acid Extractables
BTEX	benzene, toluene, ethylbenzene, and xylene
CAS	Columbia Analytical Services (Simi Valley, California)
CDM	Camp, Dresser & McKee, Inc. (Cambridge, Massachusetts)
CEA	Classification Exception Area
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act of 1980, as amended, commonly known as Superfund
CFR	Code of Federal Regulations
Clean Harbors	Clean Harbors, Inc. (Norwell, Massachusetts)
cm	centimeter
cm/s	centimeters per second
cm <sup>2</sup>	square centimeter
COC	constituent of concern
COI	constituent of interest
COPC	constituent of potential concern
CSM	conceptual site model
cSt	centistokes
DCA	dichloroethane
DCB	dichlorobenzene
DCE	dichloroethylene or dichloroethene
DCP	dichloropropane

DDD	dichlorodiphenyldichloroethane
DDE	dichlorodiphenyldichloroethylene
DMA	dimethylated arsenite
DNAPL	dense non-aqueous phase liquid
DOT	Department of Transportation
DPL	dynamic profile location
DQO	data quality objective
EDD	electronic data deliverable
EE/CA	Engineering Evaluation/Cost Analysis
EFH	Essential Fish Habitat
ELCR	excess lifetime cancer risk
Environ	ENVIRON International Corporation (Newark, New Jersey)
EPA	United States Environmental Protection Agency
ERA	Ecological Risk Assessment
EWMA	Environmental Waste Management Associates, LLC (Parsippany, New Jersey)
FEMA	Federal Emergency Management Agency
FID	flame ionization detector
foc	fraction of organic carbon
FS	feasibility study
g/M	grams per mole
GC	gas chromatograph
GIS	Geographic Information System
GSSI	Geophysical Software Systems, Inc.
GWQC	groundwater quality criterion
GWQS	groundwater quality standards
GZA	GZA GeoEnvironmental, Inc. (Norwood, Massachusetts)
HCAA	High Concentration Arsenic Area
HDNL	Health Department Notification Level
HDPE	high-density polyethylene
HHRA	Human Health Risk Assessment
HI	hazard index
HPO	Historic Preservation Office
HQ	hazard quotient
HSA	hollow-stem auger
ID	inner diameter
IDW	investigation-derived waste
IGWSCC	NJDEP Impact to Groundwater Soil Cleanup Criteria
ITRC	Interstate Technology and Regulatory Cooperation Work Group
JMA	John Milner Associates, Inc. (West Chester, Pennsylvania)

Kd	distribution coefficient
kg/m <sup>3</sup>	kilograms per cubic meter
Kh	Henry's Law Constant
Koc	organic carbon to water partition coefficient
LNAPL	light non-aqueous phase liquid
MCL	maximum contaminant level
META	META Environmental, Inc. (Watertown, Massachusetts)
µg/L	microgram per liter
mg/kg	milligram per kilogram
mg/L	milligram per liter
MGP	manufactured gas plant
MHWL	mean high water level
MHz	megahertz
mL/g	milliliter per gram
mL/min	milliliter per minute
MMA	monomethylated arsenite
MS/MSD	matrix spike and matrix spike duplicate
mV	millivolt
n	porosity
NAPL	non-aqueous phase liquid
NFA	No Further Action
NJAC	New Jersey Administrative Code
NJDEP	New Jersey Department of Environmental Protection
NJDOHSS	New Jersey Department of Health and Senior Services
NJSA	New Jersey Statutes Annotated
NJSCC	New Jersey Residential and Non-Residential Soil Cleanup Criteria
NJSM	New Jersey State Museum
NOAA	National Oceanic and Atmospheric Administration
NPL	National Priorities List
NSF	National Science Foundation
NYS&W	New York, Susquehanna and Western Railway Corporation
NZ	NAPL Zones
OBG	O'Brien & Gere Engineers, Inc. (East Syracuse, New York)
OD	outer diameter
ORP	oxidation-reduction potential
OSWER	Office of Solid Waste and Emergency Response
OU	Operable Unit
P/A	pitch/asphalt
PAH	polycyclic aromatic hydrocarbon
PAR	Pathway Analysis Report
PCB	polychlorinated biphenyl
PCE	tetrachloroethylene, tetrachloroethene, or perchloroethene



PID	photoionization detector
ppb	parts per billion
ppm	parts per million
PRG	Preliminary Remediation Goals
PS&S	Paulus, Sokolowski & Sartor, LLC (Warren, New Jersey)
PSCR	Preliminary Site Characterization Report
PVC	polyvinyl chloride
QA/QC	quality assurance/quality control
QAPP	Quality Assurance Project Plan
QED	QED Environmental Systems, Inc. (Ann Arbor, Michigan)
R	retardation factor
RAGS	Risk Assessment Guidance for Superfund
RAL	Rapid Action Levels
Raviv	Dan Raviv Associates, Inc. (Milburn, New Jersey)
RAWP	Remedial Action Work Plan
RCRA	Resource Conservation and Recovery Act, as amended
RDCSCC	Residential Direct Contact Soil Cleanup Criteria
RE	fluorescence-emitting reference
RI	Remedial Investigation
ROST™	Rapid Optical Screening Tool
RSI	Removal Site Investigation
SACM	Superfund Accelerated Cleanup Model
SCC	soil cleanup criteria
SFS	Saybolt Furol Second
SGS	SGS Environmental Services, Inc. (West Creek, New Jersey)
SI	Supplemental Investigation, pursuant to the RI/FS Work Plan Addendum No. 2
Site	Quanta Resources Superfund Site
SJB	SJB Services, Inc. (Balston Spa, New York)
SLERA	Screening Level Ecological Risk Assessment
SOW	Scope of Work
SPLP	Synthetic Precipitation Leaching Protocol (EPA Method 1312)
SRI	Supplemental Remedial Investigation, pursuant to the RI/FS Work Plan Addendum No. 4
SVOC	semi-volatile organic compound
TAL	target analyte list
TarGOST®	tar-specific, green optical screening tool (Dakota Technologies, Inc.)
TCB	trichlorobenzene
TCE	trichloroethylene or trichloroethene
TCL	target compound list
TCLP	toxicity characteristic leaching procedure (EPA Method 1311)
TKN	total Kjeldahl nitrogen
TOC	total organic carbon

TPH	total petroleum hydrocarbons
USFWS	U.S. Fish and Wildlife Service
USGS	U.S. Geological Survey
UST	underground storage tank
UVOST™	ultraviolet optical screening tool (Dakota Technologies, Inc.)
<i>v</i>	linear velocity
Vargo	Vargo Associates (Franklinville, New Jersey)
<i>vc</i>	velocity of constituent migration
VOC	volatile organic compound
XRD	x-ray diffraction
YSI	Yellow Springs Instruments®

## SECTION 1

# Introduction

---

This Final Remedial Investigation (RI) report for Operable Unit (OU) 1 of the Quanta Resources Superfund Site<sup>4</sup> (the “Site”), located in Edgewater, New Jersey (Figure 1-1), has been prepared in accordance with the requirements of the U.S. Environmental Protection Agency (EPA) Administrative Order on Consent II–Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA)–2003-2012 for the Uplands Area, OU1 (EPA, 2003). The Site is located adjacent to the Hudson River, in northeastern New Jersey. Surface water and sediment in the Hudson River are considered OU2 and are being investigated pursuant to a separate EPA Administrative Order on Consent. The Site was listed on the National Priorities List (NPL) on September 9, 2002. Consistent with the OU1 Administrative Order, the site characterization, remedial evaluation, and selection process are being conducted pursuant to the EPA National Oil and Hazardous Substances Pollution Contingency Plan (40 Code of Federal Regulations [CFR] 300), *Guidance for Conducting Remedial Investigations and Feasibility Studies Under CERCLA* (EPA, 1988), and other relevant guidance as stated in this report.

This RI report presents the data and information related to the work prescribed in the EPA-approved “OU1 Remedial Investigation/Feasibility Study (RI/FS) Work Plan” (Parsons, 2005) and associated Field Sampling Plan, Health and Safety Plan, and Quality Assurance Project Plan (QAPP), subsequent RI/FS Work Plan addendums for OU1, and additional activities in response to EPA requests, as described below.

Initial RI field activities were conducted from July 2005 to December 2006. EPA provided oversight by an independent observer, Camp Dresser & McKee, Inc. (CDM). CDM documented the field activities and collected split samples of the various media collected during all phases of the RI activities. CDM has issued no information to date, nor did CDM share any comments in the field; accordingly, no issues are assumed to exist with the data collection associated with the results presented herein.

A draft version of this RI Report was submitted to the EPA and New Jersey Department of Environmental Protection (hereafter referred to as the Agencies) on November 17, 2007. Comments were received from the agencies via Federal Express on April 7, 2008 (EPA, 2008) and have been incorporated into this Final RI Report, with the exception of select agency comments that are being addressed through additional data collection activities and subsequent evaluations in accordance with the “Final Remedial Investigation/Feasibility Study (RI/FS) Work Plan Addendum No. 4 for a Supplemental Remedial Investigation (SRI)” (CH2M HILL, 2008a). This additional work is currently ongoing and will be summarized in a Supplemental RI Report, which will serve to update the applicable components of this report, address the agencies’ remaining comments, and complete the RI process for the Site.

---

<sup>4</sup> As defined in the Administrative Order on Consent (AOC) II-CERCLA-2003-2012, the Quanta Resources Superfund Site includes the former Quanta Resources property, located on River Road in Edgewater, New Jersey, and any areas where contamination from the property has come to be located. The current Quanta property refers to Block 95, Lot 1, as defined on the Borough of Edgewater, New Jersey, tax map.

## 1.1 Original RI/FS Work Plan

The original RI/FS Work Plan, QAPP, and Field Sampling Plan were approved by EPA on May 2, 2005 (EPA, 2005). The QAPP and Health and Safety Plan were revised in October 2005 and July 2005, respectively (CH2M HILL, 2005a, b). The revised QAPP was approved on January 11, 2006 (EPA, 2006a), and the QAPP was again revised in November 2006 (CH2M HILL, 2006a).

In February 2006, the "Draft Preliminary Site Characterization Report" (PSCR) was submitted to EPA for review (CH2M HILL, 2006b). The information in the PSCR was presented to EPA and the New Jersey Department of Environmental Protection (NJDEP) on March 20, 2006. The Draft PSCR summarized historical and RI data for OU1 that had been collected prior to the end of 2005.

RI data summarized in the Draft PSCR include the following:

- Survey of subsurface utilities
- Completion of 48 soil borings
- Collection and analysis of 107 soil samples
- Installation of 30 permanent monitoring wells at varying screen intervals
- Development of all monitoring wells
- Measurements of synoptic water level and non-aqueous phase liquid (NAPL) thickness (three quarterly events)
- Groundwater sampling of new and existing monitoring wells (three quarterly events)
- Collection and analysis of five NAPL samples
- Testing of in situ hydraulic conductivity at 14 wells and across all hydrostratigraphic units
- Survey of potential preferential pathways
- Collection and analysis of five water samples in areas where seasonal standing water had been observed
- Study of potential tidal influences on groundwater flow
- Survey of OU1

The purpose of the Draft PSCR was to identify any remaining data gaps for the RI, to support the preparation of risk evaluations and the RI report, and to provide a basis for the development and screening of remedial alternatives along with identification and refinement of applicable or relevant and appropriate requirements (ARARs).

Following the submission of the Draft PSCR, RI data collection activities continued in accordance with the RI/FS Work Plan (Parsons, 2005). These additional activities included the following:

- Completion of three soil borings
- Collection and analysis of 12 soil samples for laboratory analysis
- Installation of six permanent monitoring wells
- Development of newly installed monitoring wells
- Completion of four rounds of synoptic water level and NAPL thickness measurements in 2006 (February, May, August, and October)
- Completion of four comprehensive groundwater monitoring events at new and existing monitoring wells in 2006 (February, May, August, and October)
- Collection and analysis of one additional NAPL sample
- Site survey for new borings and wells

As indicated in the Draft PSCR and as presented to EPA and NJDEP on March 20, 2006, certain data gaps remained at the Site with respect to the RI, which included the delineation of select constituents of interest (COIs) and NAPL. EPA provided written comments on the Draft PSCR in a letter dated June 30, 2006 (EPA, 2006b). In a letter dated July 17, 2006 (CH2M HILL, 2006c), CH2M HILL acknowledged receipt of the comments and notified EPA of the intent to address them by submission and implementation of an RI/FS Work Plan Addendum.

## 1.2 RI/FS Work Plan Addendum No. 1

The “Remedial Investigation/Feasibility Study Work Plan Addendum” (CH2M HILL, 2006d), submitted in July 2006, presented a supplemental RI/FS scope to address data gaps identified in the Draft PSCR and by EPA in its June 30, 2006, comment letter. The scope described in the RI/FS Work Plan Addendum (also referred to as the Supplemental Investigation [SI]) was implemented between October and November 2006, and results are included in the information presented herein. Supplemental RI activities performed in accordance with the RI/FS Work Plan Addendum included the following:

- Acquisition and review of data and digital data uploading to the Site database
- Interpretation of adjacent property investigation reports
- Supplemental characterization of the extent of arsenic and other metals in soil through sampling performed at 30 locations
- Expanded preferential pathways evaluation
- Coal tar NAPL delineation using tar-specific, green optical screening tool (TarGOST®) profiling and confirmatory soil sampling
- Groundwater monitoring at the former Lever Brothers property
- Site survey for new borings and wells

## 1.3 RI/FS Work Plan Addendum Nos. 2 and 4

Following completion of the scope of the SI, the combined RI data set was evaluated and, on December 19, 2006, presented to EPA and NJDEP. Additional data gaps focusing primarily on the extent of NAPL constituents south and southwest of the Site were identified and presented to EPA during the meeting. Preparation of the Draft RI Report proceeded despite the remaining data gaps, since addressing these data gaps was not expected to fundamentally change the outcome of remedial option evaluations for the Site using the existing data set. The data gaps identified included determination of the distribution and extent of NAPL and Site-related constituents at Block 93 and the northwest portions of the Lever Brothers property; the extent of Site-related, dissolved-phase constituents in groundwater at Block 93; the extent of arsenic in groundwater surrounding the MW-111 cluster of wells; and a determination of the groundwater flow direction in the north portion of Block 93. The “Proposed Scope of Work—Supplemental Data Gap Sampling,” which was designed to address these data gaps, was submitted to EPA on March 22, 2007, for review (CH2M HILL, 2007a). CH2M HILL proposed addressing data gaps through additional TarGOST® profiling to delineate the extent of NAPL, through installation of additional monitoring wells, and through further soil sampling and groundwater sampling.

Following the receipt from the agencies of comments on the Draft RI Report (EPA, 2008), RI/FS Work Plan Addendum No. 2 was updated and resubmitted in May 2008 as the “Draft RI/FS Work Plan Addendum No. 4 for an SRI” (CH2M HILL, 2008b). Comments on this work plan, received from the agencies via e-mail messages sent on June 19, June 27, and July 8, 2008, were addressed and incorporated into the “Final RI/FS Work Plan Addendum No. 4 for an SRI” (CH2M HILL, 2008a), which was designed to address data gaps described in this RI Report at Block 93, Block 94 (west of Old River Road), and the northwestern portion of the former Lever Brothers property. Additional work components are proposed in order to address selected agency comments on the draft version of this RI Report (EPA, 2008) that highlight uncertainties or data gaps that require additional investigation. The results of the proposed work will be summarized in a Supplemental RI Report that will update the applicable components of this Final RI Report, address the remaining agency comments, and complete the RI process for the Site.

## 1.4 RI/FS Work Plan Addendum No. 3

On November 27, 2006, EPA requested that a “characterization of arsenic and cinders” be conducted. In response to this request, a summary of existing metals data and other field observations were submitted to EPA in the “Summary of the OU1 Supplemental Investigation Metals Soil Sampling and Evaluation of Cinder/Ash and Pyrite-Impacted Soils” technical memorandum (CH2M HILL, 2007b). This technical memorandum evaluated the SI results with respect to arsenic in soils and the occurrence of pyrite cinder-impacted soils and cinder/ash fill material at the Site. Subsequent conversations with EPA led to the development of a Scope of Work (SOW) to characterize the cinder/ash and reddish-purple soils suspected to be contaminated by pyrite cinders (CH2M HILL, 2007c). EPA comments on the SOW (EPA, 2007a) led to the development of the “Remedial Investigation/ Feasibility Study Work Plan Addendum No. 3 and Field Sampling Plan for the Characterization of Cinder/Ash and Reddish-Purple Soils” (CH2M HILL, 2007d). After receiving EPA approval

of the work plan on May 4, 2007 (EPA, 2007b), fieldwork was begun and completed in June 2007. Activities performed as part of the characterization of cinder/ash and reddish-purple soils include the following activities:

- Completion of nine soil borings
- Collection of 17 soil samples and one slag sample for laboratory analysis
- Installation and development of six temporary well points
- Collection and analysis of groundwater samples from each of six temporary well points
- Site survey for new borings and temporary wells

In addition to the RI data collection activities performed in accordance with the RI/FS Work Plan and the two approved RI/FS Work Plan Addenda, activities performed in response to EPA requests and discussed in this RI Report include the following:

- **115 River Road Vapor Intrusion Evaluations**, including the collection of indoor, outdoor, and subslab air samples in March and July 2006 in accordance with the EPA-approved “Vapor Intrusion Evaluation Work Plan” (CH2M HILL, 2006e) and in March and April 2008
- **115 River Road Product Inventory Survey**
- **115 River Road Building Pressurization Survey**
- **Jono’s Restaurant Building Vapor Intrusion Evaluations**, including collection of six groundwater grab samples in June 2007 and collection of indoor, outdoor, and subslab air samples in March 2008
- **Seasonal Standing Water Evaluation**, including collection of four samples of accumulated standing water at the Quanta property
- **NAPL Recovery Testing**, including pumping of NAPL from monitoring wells in December 2006 and July 2007 and follow-up measurements of NAPL thickness
- **Arsenic Dust Evaluation**, including collection of 12 surface soil samples from the Quanta property and evaluation of the potential air pathway based on the procedures in “Rapid Assessment of Exposure to Particulate Emissions from Surface Contamination” (Cowherd et. al., 1985)
- **Cultural Resources Survey**, conducted in accordance with the “OU1 Cultural Resources Study Work Plan” (CH2M HILL, 2007e) as approved by EPA on February 26, 2007
- **Treatability Study Sample Collection**, conducted in accordance with the “In Situ Chemical Oxidation Treatability Study Work Plan” (CH2M HILL, 2007f), included collection of samples from three locations on the Quanta property (Results of treatability testing will be provided to EPA in the FS Report for OU1; however, observations made during sampling are included in this RI Report.)

The combined RI dataset, including the results of the work outlined in the RI/FS Work Plan and subsequent RI/FS Work Plan addenda, additional activities in response to EPA requests (as listed above), historical information for the Site, and data obtained from consultants for

adjacent property owners, is intended to adequately delineate the nature and extent of NAPL and other soil and groundwater impacts related to historical Site operations.

## 1.5 Definitions

Definitions that will be used throughout this document include the following.

- **Quanta property:** The land portion of Block 95, Lot 1, in Edgewater, New Jersey.
- **Former Quanta Resources property:** The land portion of Block 95, Lot 1, and Block 93, Lot 1, as well as the portion of River Road between these lots.
- **Quanta Resources Superfund Site:** As defined in the AOC II-CERCLA-2003-2012, the Quanta Resources Superfund Site (or “Site”) includes “the former Quanta Resources Site and any areas where contamination from the Site has come to be located.” The extent of OU1 is defined in Section 4.7.
- **Former Barrett property:** The maximum extent of Barrett Manufacturing Company operations as depicted on historical Sanborn® fire insurance maps (1900, 1911, 1930, 1944, 1950, and 1968, included in Appendix A).
- **NAPL:** Non-aqueous phase liquid, or “product.” NAPL can exist as a single chemical component or as a mixture, and it can occur in soils in free-phase or residual states. Residual NAPL is defined as being immobile when soil capillary forces are greater than gravity and hydraulic forces (Cohen and Mercer, 1993). Free-phase NAPL moves under the force of gravity and hydraulic forces. In this report, the term “NAPL” refers to both free-phase and residual states, unless otherwise noted.
- **LNAPL:** Light non-aqueous phase liquid. LNAPL has a density less than 1.0.
- **DNAPL:** Dense non-aqueous phase liquid. DNAPL has a density greater than 1.0.
- **Coal tar,** characterized by a complex mixture of compounds, typically complex hydrocarbons and other byproducts from former manufactured gas plant (MGP) operations (Hayes et al., 1996; EPA, 2000). At the Site, coal tar was delivered to the former Barrett property for use by the Barrett Company Shadyside<sup>5</sup> Plant for production of roofing paper and other materials.
- **COI,** present at concentrations exceeding one or more screening criteria
- **COC,** present at concentrations exceeding calculated acceptable risk ranges in the Ecological and Human Health Risk Assessments

## 1.6 Purpose

As stated in the RI/FS Work Plan (Parsons, 2005), the specific objectives of the RI for OU1 are the following:

---

<sup>5</sup> The town of Edgewater was formerly known as Shadyside, New Jersey.



- Characterize potential soil and groundwater impacts associated with the former operations of the Site
- Define the nature and extent of contamination and delineate those impacts caused by the release or threatened release of constituents at or from the Upland Area of the Site, including groundwater and soil
- Evaluate the potential for human health and ecological impacts associated with the former operations at the Site
- Develop supplemental data sufficient to address data gaps within the investigations conducted to date to determine the need for and to allow a screening of appropriate remedial alternatives, recommendation of the most appropriate remedial alternative, and development of a refined conceptual site model after a public comment process. EPA will be responsible for the selection of the final remedial alternative

Specific data quality objectives (DQOs) were developed for each investigation and are discussed in Section 2 of this report.

## 1.7 Report Organization

This RI report describes the investigation activities completed as part of the RI for OU1 and presents an evaluation of historical and recently collected data:

- Section 1 presents a brief description and history of the Site and the surrounding properties and summarizes previous investigations conducted at the Site.
- Section 2 includes descriptions of the field activities conducted in accordance with work plans described in the previous subsection.
- Section 3 presents the Site characteristics, including surface features and preferential pathways, Site-specific geology and hydrogeology, land use, and ecology.
- Section 4 presents the findings for the field investigation and historical data, including constituents of interest and the nature and extent of contamination in Site media.
- Section 5 presents an evaluation of the fate and transport of constituents at the Site and their migration and persistence.
- Section 6 presents the conceptual site model for OU1.
- Section 7 summarizes the work performed to date for the human health and ecological risk assessments.
- Section 8 presents the summary and conclusions of the RI report and recommendations for future work.
- Section 9 lists the references used during the preparation of the RI Report.

Figures and tables, listed in the table of contents, are referenced throughout the text and are found at the end of the report text. Seventeen appendixes (A through Q) present detailed

supporting information, analytical data, and field observations used to develop the evaluations presented in this report.

## 1.8 Site Background

### 1.8.1 Operable Unit 1 Description

As noted earlier, the Site consists of the former Quanta Resources property and any locations to which contamination from the property and former operations has migrated. The physical boundaries of OU1 are defined in Section 4 of this RI Report. Surface water and sediment in the Hudson River adjacent to OU1 constitute OU2 and are being investigated and addressed separately. As further described in Section 4.7, impacts from former operations associated with the Site have been observed on portions of the following areas, which together compose OU1:

- Block 95, Lot 1 (referred to as the Quanta property)
- Block 91, Lot 1 (referred to as the former Celotex property or the [former] Edgewater Enterprises property<sup>6</sup>)
- Block 96, Lot 3.01 (referred to as the 115 River Road property)
- Block 99, Lot 1 (referred to as the former Lever Brothers property)
- River Road and Gorge Road
- Block 93 (broken into three components for purposes of this report, based on varying current and foreseeable land use)

Figure 1-2 shows each of these properties relative to the Quanta property. Complete descriptions of past operations on each of these properties are provided in Appendix A. Additional details on the current surficial features of each property are provided in Section 3.1.

### 1.8.2 Site History

The history of the properties in the vicinity of or comprising the Site is summarized in this section and described in detail in Appendix A, which includes ownership history. The Quanta property is located at 163 River Road in Bergen County, Edgewater, New Jersey (Figure 1-2). From approximately 1878 to 1971, a large portion of the Site was used to process coal tar and produce paving and roofing materials, first by Barrett Manufacturing Company and later by Allied Chemical Corporation. Sanborn® fire insurance maps from 1900 to 1944 identify the property as the “Barrett Company’s Shadyside Plant, Manufacturers of Tar Products.” Allied Chemical Corporation’s Asphalt Division took over operations of the coal tar distillation plant in the early 1930s. The maximum extent of Barrett Manufacturing operations is depicted in Figure 1-3. The coal tar processing plant operated until 1974, when the former Barrett property was sold to James Frola (now deceased) and Albert Von Dohln. From 1974 through 1980, the property was operated by numerous

---

<sup>6</sup> Edgewater Enterprises, LLC, was a former owner of Block 91, Lot 1. The chain of title is provided in Appendix A.

entities involved in the oil recycling business, many of which were owned or controlled by Russell Mahler. In 1977, the former Barrett property was leased to E.R.P. Corporation for the storage and recycling of oil. The lease was assigned to Edgewater Terminals, Inc., and then transferred to Quanta Resources Corporation in July 1980. The property contained 61 aboveground storage tanks (ASTs), at least 10 underground storage tanks (UST), septic tanks, and underground piping. The total storage capacity of the tanks was over 9 million gallons. Figure 1-3 shows pertinent historical features such as ASTs, USTs, process area buildings, and piping that have been documented by Sanborn® Fire Insurance Maps and private insurance maps.

NJDEP closed the facility in 1981 after discovering polychlorinated biphenyls (PCBs) in some of the oil stored at the facility. On October 6, 1981, Quanta Resources Corporation filed for bankruptcy, after which the property was no longer in use. Following operational shutdown, NJDEP requested that EPA address Site contamination pursuant to CERCLA.

Several removal actions conducted at the Site from 1984 to 1988 under EPA oversight focused on the cleaning and decommissioning of the ASTs and USTs. Several million gallons of product had been removed and disposed of or recycled by 1988. Some underground piping and shallow soils were removed (Parsons, 2005). The removal actions were assessed by EPA in 1992 through the collection and analysis of soil, sediment, and groundwater samples from the Site. Additional investigations conducted prior to and subsequent to the removal actions are described in Section 1.9.3.

In 1995, the Borough of Edgewater acquired a portion of the Site for a right-of-way for (new) River Road. In 1996, EPA entered into an Administrative Order on Consent with the County of Bergen and Metropolitan Edgewater Associates, LP, to allow the County of Bergen to construct a road over a portion of the Site and to provide protection against direct contact risks to workers or future users of the road (EPA, 2003).

EPA entered into an Administrative Order on Consent (II-CERCLA-96-0105) with AlliedSignal in 1996 to perform a removal investigation of the Site (EPA, 2003). After intermittent sheens became visible at the waterfront in 1997, EPA mandated that a collection trench be built to prevent oil from continuing to seep to the Hudson River. Prior to submission of the final trench design, EPA stopped the proposed construction (Parsons, 2005) because the trench, as proposed, would not have addressed seeps/sheens on adjacent properties. AlliedSignal entered into an Administrative Order on Consent with EPA in 1998 to conduct a Removal Site Investigation (RSI) and prepare an Engineering Evaluation/Cost Analysis (EE/CA) to characterize conditions and to develop a solution to the seeps. The EE/CA evaluated select non-time critical removal actions, which would be implemented in accordance with the EPA Superfund Accelerated Cleanup Model (SACM), intended to achieve prompt risk reduction (GeoSyntec, 1999).

In February 2000, EPA rejected the EE/CA removal action recommendations because EPA believed the design would have been ineffective in preventing coal tar releases to the Hudson River. EPA recommended that additional, more-effective alternatives or technologies be evaluated and that an ecological evaluation be conducted for the tidal mud flats of the Hudson River. Two revised EE/CA reports (GeoSyntec, 2000a, 2001) were submitted to address the concerns of EPA. The EE/CA listed two overall objectives of the response action: to “mitigate the migration of NAPL, buried within the mud flat sediments,

to the water column, if indeed vertical migration of the buried NAPL is occurring” and to “recover/contain NAPL in upland areas where practicable.” The EE/CA evaluated five remedial alternatives and recommended the construction of two trenches to collect light and heavy oil fractions (GeoSyntec, 2001).

On September 9, 2002, EPA placed the Quanta Resources Superfund Site on the NPL. In 2004, an AOC was signed between EPA and 23 respondents to conduct an RI/FS to fill data gaps in previous investigations and to provide a basis for a complete evaluation of alternatives. In May 2005, Parsons submitted the RI/FS Work Plan for OU1 to EPA (Parsons, 2005).

### **Former Celotex Property**

The former Celotex property is just north of the Quanta property (Figure 1-2). The former Celotex property has been the site of a chemical plant, a gypsum company, a vacuum truck company, and a metal reclaiming/refinishing plant. The chemical plant, General Chemical Company, operated on the southern portion of the property from at least 1900 until 1957. The chemical plant was used to produce acids, alums, sodium compounds, and sulfuric acid (Parsons, 2005). A gypsum company and a vacuum truck company also occupied the property; after 1974, a metal-reclaiming and refinishing plant operated on the southern portion of the property. Former operations at the former Celotex property might have contributed to the presence of constituents similar to those detected at the Quanta property.

Since 1988, approximately 4 to 16 feet of fill material appears to have been placed on the former Celotex property (Environ, 2005). Additional fill material (more than 8 feet) recently was placed on the southeastern side of the former Celotex property adjacent to the Quanta property; this area has been developed as a parking lot. Redevelopment of the property included installation of a cap that partially contains reused soil from other portions of the property.

Redevelopment of this property is ongoing, and attempts recently have been made to further define the northern extent of Site-related NAPL as part of this process. Remedial activities on the property have been conducted under an Administrative Order on Consent between Edgewater Enterprises and NJDEP authorizing Edgewater Enterprises, under NJDEP oversight, to conduct all the remedial activities necessary for the site. In an Administrative Order on Consent with EPA (CERCLA-02-2003-2014), Edgewater Enterprises was authorized to construct a temporary access roadway over an area including a portion of the Quanta Resources Superfund Site. Use of the southern portion of the former Celotex property is limited until the RI/FS for the Quanta Resources Superfund Site has been completed.

### **115 River Road Property**

Bordering the Quanta property to the south is the 115 River Road, LLC, office complex. The property at 115 River Road had been used by Spencer-Kellogg for manufacturing linseed and/or cottonseed oil (Appendix A). The current office complex consists of three buildings. The main 115 River Road building consists of two attached buildings (shown in Figure 1-4). The western portion of this building, located between River Road and the Hudson River, is approximately 500 feet long and dates back to the turn of the twentieth century. This building is constructed of brick and has two separate basements. The second office building

consists of an approximately 300-foot-long expansion of the main building, extending over the Hudson River on a pier. The extension is referred to in Figure 1-4 as the “pier building.” A smaller, two-story brick building (Building 12) is located to the north of the main 115 River Road building. The buildings were renovated in 1986 as offices.

### **Former Lever Brothers Property**

South of the 115 River Road property is the former Lever Brothers property, formerly owned and operated by Unilever, a division of Conopco, Inc., and currently owned by i.Park Edgewater, LLC. The property consists of Block 99 Lots 1, 3, 4, and 5. The land portion of the property is bordered on the east by the Hudson River and on the west by River Road. It is currently in the process of being redeveloped for mixed-use residential and commercial purposes.

The 1911 Sanborn® Fire Insurance map (Appendix A) for this property indicates that it was occupied by “Pyle’s Pearline Works, Mfg of Soap & Pearline.” Buildings on this property are labeled as containing caustic soda in drums and being used for pearline storage and drying and advertising-matter storage. The 1930 Sanborn® fire insurance map depicts buildings north of a set of railroad tracks marked as vacant. South of the rail tracks, no features are shown. The property is marked as “Lever Bro’s. Co. owners, not in operation.”

Prior to Lever Brothers operations on the property, which began in the early 1930s, a portion of this property reportedly was owned by the Barrett Company (NJDEP, 1989). The portion of the property this report refers to is unclear, as is the basis of this assertion. Sanborn® Fire Insurance maps from around this time (1909, 1911, and 1930) do not indicate that the Barrett Company had active operations on any portion of the former Lever Brothers property. However, later Barrett Division operations appear to have occurred on Block 99, Lots 5–8, which were reportedly leased from Frederick G. Holst by Barrett Division in 1943. An EPA photograph review indicates the presence of “a large linear amount of material, which appears to be partially contained by a wall” (EPA, 2006c). This structure is referred to as a pitch bay in the “Supplemental Remedial Investigation Report and Remedial Action Workplan” for the former Lever Brothers property (GZA, 2007b). The report also concludes, based on a review of aerial photographs, that “pitch material from the impoundment was spread across the southern portion of the Site for use as fill material.” Lever Brothers purchased Block 99, Lots 5–8, from F.G. Holst in 1944 (NJDEP, 1989).

By 1986, all tanks and nearly all former operations buildings had been removed from the north and center portions of the property. A parking lot had been constructed along the northern border of the property, and a building had been constructed in the parking area between the former railroad tracks and (old) River Road. Additional parking areas were later constructed in the north portion of the property, as well as a new building between two of the parking lots. The realignment of River Road roughly follows the former railway through the property.

### **Block 93 North**

The current building on Block 93, Lot 1 was reportedly used as a quality control laboratory by Allied Chemical until 1974 (O’Brien & Gere Engineers, Inc. [OBG], 2004). The building remained vacant for approximately 10 years, after which it was used for miscellaneous purposes (as an office, for storage, and as a musical rehearsal studio) before being converted

to a restaurant in the early 1990s. The restaurant was vacant for a period of time and has now been refurbished. An occupancy permit application is believed to be pending for the restaurant.

Block 93, Lot 2 historically included railroad tracks used for chemical shipping and receiving. This portion of the property was owned by the New York, Susquehanna and Western Railway Corporation (NYS&W). The tracks were removed, reportedly in 1988, and the lot was subdivided (OBG, 2004). James Frola acquired the northern portion of the lot in 1988 and sold the property to Thomas Heagney in 1999. Anthony Besthoff purchased the southern portion of Lot 2 from the railway in 2003 (OBG, 2004), and for purposes of this report it is considered part of Block 93 Central.

### **Block 93 Central**

The former Faesy & Besthoff property, also known as Block 93 Central, occupies Lots 1.01, 3.03, 3.04, and the southern portion of Lot 2, between Old River Road and River Road. Currently, MB Edgewater, LLC, owns Lots 1.01 and 3.03.

In 1980, NYS&W railroad owned and occupied Lot 2 of Block 93. Faesy & Besthoff, Inc., an agricultural-chemical-blending and -packaging facility, utilized tracks along Lot 2, apparently before owning portions of Block 93.

Lot 2 was subdivided after the railroad tracks were removed (reportedly in 1988). James Frola acquired the northern portion of the lot in 1988 and sold the property to Thomas Heagney in 1999; this is a component of Block 93 North, as described above. Anthony Besthoff purchased the southern portion of Lot 2 from the railway in 2003 (OBG, 2004).

Lot 3.04 is currently owned by Thomas Heagney.

### **Block 93 South**

Block 93 South consists of Block 93, Lot 4. An outpatient medical building, owned by Metropolitan Consum, LLC, currently occupies the property. The property is mostly paved to serve as a customer parking area with the remaining areas covered by landscaping. Lever Brothers Company owned Block 93, Lot 4, from 1920 through 1996.

## **1.8.3 Previous Investigations**

In addition to investigations completed as part of the RI/FS for OU1, reports of results for previous investigations, including those of adjacent properties, were reviewed and included as appropriate in this RI report. These investigations are summarized below by property. The RI evaluations presented in this report use only relevant historical data from investigations where the data collection was overseen by EPA or NJDEP or the data have otherwise been deemed valid. At the agencies' request, the conclusions drawn in the following reports regarding the Former Celotex Industrial Park were not included in this RI report:

- Final Soil Remediation Investigation Report—Arsenic Area (Raviv, 2002)
- Groundwater Remedial Investigation Report, Arsenic Area (Raviv, 2004)
- Coal Tar Remedial Investigation Report—700 Building and Coal Tar Delineation Limits, Building 700 Area and South (EWMA, 2003)

- Supplemental Groundwater Investigation Report – Arsenic Area (Raviv, 2005)
- Supplemental Coal Tar Delineation Report (EWMA, 2004a)

### Former Quanta Resources Property

Products stored at the former Quanta Resources property include coal tar, waste oil, asphalt, ammonia, and roofing materials. Summaries of past investigations conducted at the former Quanta Resources property to identify or delineate contamination are provided below.

**1990 Soil Investigation.** A 1990 soil investigation conducted by Paulus, Sokolowski & Sartor, LLC (PS&S) included the collection of 11 soil samples from eight soil borings throughout the Site (PS&S, 2002). Samples were collected from the 0.0- to 0.5-foot interval from all borings, and from the 4- to 6-foot interval in three of the borings. All samples were analyzed for EPA priority pollutants (40-peak library search) and total petroleum hydrocarbons (TPH). Arsenic, lead, mercury, thallium, and zinc were detected above NJDEP residential direct contact soil cleanup criteria (RDCSCC). Benzene was the only volatile organic compound (VOC) detected above RDCSCC, although both benzene and total xylenes exceeded the impact to groundwater soil cleanup criteria (IGWSCC) in at least one location. Detected base-neutral (BN) organic compounds, mostly polycyclic aromatic hydrocarbons (PAHs), generally exceeded RDCSCC. TPH was detected at concentrations up to 38,000 mg/kg. Pesticides were detected in six samples, one of which exceeded RDCSCC. PCBs were not detected during this investigation.

**1992 and 1995 EPA Site Assessments.** Parsons' (1999) summary report indicates that EPA assessments in 1992 and 1995 documented impacts of surface and subsurface soil, Hudson River sediments, and groundwater. Constituents detected included arsenic, asbestos, benzene, metals, PAHs, TPH, and VOCs.

**1997 Predesign Investigation.** Parsons conducted a predesign investigation in March 1997 to fill certain data gaps as follows. Five surface soil samples were collected near a former PCB "hot spot" and analyzed for PCBs, TPH, and the toxicity characteristic leaching procedure (TCLP). Insulation material in two boilers in a building was sampled for asbestos, and a magnetometer survey was conducted to identify two potential USTs as well as the property and its topography generally. PCBs were detected in all soil samples at concentrations from 0.38 to 3.65 mg/kg. TPH was detected in all five samples, with diesel range concentrations up to 8,600 mg/kg. TCLP volatiles were not detected in any sample, and lead was detected below the regulatory limit of 5 mg/L. Asbestos was detected in the insulation material from both boilers. The magnetometer survey failed to locate the two suspected USTs because of interference from reinforced concrete. The report recommended no action on the basis of PCB, TPH, or TCLP results. Removal of asbestos material from the boilers and excavation of a test pit to locate the suspected USTs were recommended (Parsons, 1997, 1998).

Additional predesign investigations were conducted in July, August, and September 1997 to obtain information pertaining to the suspected USTs and underground piping and to gather information concerning any shallow, low-permeability units near the proposed location of a planned recovery trench. Eleven test pits were completed and 14 soil borings were advanced in the eastern portion of the former Quanta Resources property. One groundwater sample was collected from a test pit and analyzed for VOCs, semi-volatile organic compounds (SVOCs), and TCLP. Results of these analyses were not provided in the data

report. No USTs were located during test pit activities, although several steel pipes were encountered. The clayey silt layer in the vicinity of the proposed recovery trench was encountered between 10 and 12 feet bgs.

**2000 Soil Investigation.** A soil investigation that PS&S conducted in June 2000 included the collection of 18 soil samples from 10 borings in the northwest corner of the Quanta property near its border with the former Celotex property. Samples were typically collected from 0.5 and 3.5 feet bgs. All samples were analyzed for arsenic, and five of the samples also were analyzed for other metals, VOCs, SVOCs, PCBs, and pesticides. The 2002 supplemental data submission (PS&S, 2002) indicated that elevated concentrations of arsenic relative to general Site conditions had been reported in several borings, particularly in the subsurface samples from those borings. Several other metals were detected above RDCSCC in one or more samples. PAH data were consistent with other Site data, and no VOCs, PCBs, or pesticides exceeded NJDEP screening criteria.

**2000 Removal Site Investigation.** The RSI was conducted by GeoSyntec (2000b) to

- (i) identify possible conduits for the transport of coal tar product from source areas to the Hudson River; (ii) delineate source areas which continue to impact soil, river sediment, and groundwater; (iii) characterize the nature and extent of soil, river sediment, and groundwater contamination; and (iv) provide data on the geotechnical properties of the [Site] soils in support of evaluation of engineered site remedies.

The scope of work for the RSI included test trenching and a geophysical survey, soil boring advancement, cone penetrometer testing, sediment sampling, monitoring well installation and groundwater sampling, and a geotechnical engineering evaluation. Field activities were conducted in 1998 and 1999, including completion of 17 test trenches, 14 soil borings, 10 monitoring wells, and 23 cone penetrometer test/rapid optical screening tool (ROST™) locations. Nine surface soil samples, 26 sediment cores, and 10 deeper Vibracore sediment samples were collected. Ten cone penetrometer test/ROST™ locations were completed in sediment. Twenty existing groundwater monitoring wells and 8 of the 10 new monitoring wells were sampled during the RSI. Surveying and tidal fluctuation monitoring also were conducted.

The RSI report concluded the following with respect to OU1:

- **Soil:** Soil samples supplemented previous collected data to delineate the extent of COIs (PAHs, arsenic, chromium, and lead) in soil. Arsenic, chromium, and lead were detected at locations scattered across the Site, indicating that metal impacts were limited to releases in localized areas and are not widespread. PCB detections were described as limited to soils in the former transformer locations. PAHs were detected throughout soil at the Site, but elevated concentrations were limited to source areas. A significant amount of soil data from the former Celotex and former Lustrelon (north of the former Celotex property) properties were obtained during previous investigations. The report suggested that soils from these areas might have already been remediated.
- **Groundwater:** Arsenic, chromium, and lead were present in a localized area and transport of these constituents downgradient of this area is limited by geochemical conditions at the Site. PCBs were not detected in groundwater. SVOCs were detected in groundwater at the majority of sampling locations at the Site, but results indicated that



two separate areas of VOCs exist. The first area contains benzene, toluene, and xylene at the Quanta property. The second area contains chlorinated ethane constituents and is limited to the former Lustrelon property (north of the study area). SVOCs were detected in groundwater at the Site. The highest SVOC concentrations were detected in areas associated with coal tar.

- **Extent of NAPL:** The NAPL extent is limited vertically by the presence of lower-permeability native soil. The NAPL varies in viscosity from solid nonmobile product to thick, viscous product. NAPL has collected in monitoring wells at the Site and is adjacent to the bulkhead. Sheens observed in the Hudson River appear to develop from both the upland source area and the sediment source area. The RSI report also concluded that NAPL in the fill adjacent to the bulkhead is able to flow and exists at a higher elevation than the river sediments. The RSI concluded that the NAPL has the potential to flow to the river through the fill material that has higher permeability due to the abundance of debris and poor compaction. The extent, fate, and transport of NAPL have been further evaluated since the submission of the RSI and will be discussed in later sections of this RI Report.

Groundwater analytical data from the RSI sampling events in 1998 and 1999 (Geosyntec, 2000a, b) are similar in terms of constituents and concentrations detected during the RI sampling events (since 2005). Exceptions to this are as follows:

- MW-102 shows a decrease in several PAH and SVOC compounds.
- At MW-106, many PAH compounds, including naphthalene (1,200 µg/L during the RSI), are no longer detected. Also at MW-106, benzene, toluene, ethylbenzene, and xylene (BTEX); carbazole; and dibenzofuran are no longer detected.
- At MW-103, several SVOC compounds and styrene (from 1,200 µg/L to nondetect) show decreasing concentrations, but increases are noted in carbazole and dibenzofuran from nondetect to 300 µg/L and nondetect to 180 µg/L, respectively.
- At MW-107, 2,4-dimethylphenol and 4-methylphenol concentrations decreased (2,200 to 72 µg/L and 430 to 13 µg/L, respectively). For location MW-108, acetone and BTEX compounds were not detected during the RI, except for an estimated concentration for total xylenes of 0.2 J µg/L.
- Compared to data collected in 1998 as part of the RSI, arsenic concentrations at MW-20 in the southern portion of the former Celotex property have been reduced by more than an order of magnitude, from 4,450 µg/L to 102 µg/L.
- For location MW-108, low levels of acetone and BTEX compounds detected during the RSI were not detected during the RI, except for an estimated concentration for total xylenes of 0.2 J µg/L.

**Engineering Evaluation/Cost Analysis Revision 2.** EE/CAs were prepared to evaluate potential response actions to be undertaken by the responsible parties to mitigate current and future releases from the Site. The revised and final EE/CA evaluated alternatives that addressed the releases of NAPL to the Hudson River and upland contamination (GeoSyntec, 2001).

**Public Health Assessment.** Representatives of the New Jersey Department of Health and Senior Services (NJDOHSS), the Agency for Toxic Substances and Disease Registry (ATSDR), NJDEP, and EPA visited the Site on January 19, 2001, and NJDOHSS conducted a public health assessment (NJDOHSS, 2002). For each of the potential pathways evaluated (i.e., surface soil and dust, ambient air, and sediment), it was concluded that there was no route of exposure element present to complete the human exposure pathway at the Site. According to the assessment, this is due to the fact that the Site was closed to entry, portions of the Site were covered with asphalt, and no work activity was occurring onsite. During both Site visits, however, indications of trespassers at the Site were apparent (e.g., footprints and evidence of individuals having walked their dogs). The potential for exposure to these individuals on a routine basis was considered unlikely and did not justify a completed exposure pathway designation. Based upon available information and observation at the Site, potential human exposure routes included dermal contact with and/or incidental ingestion of contaminated onsite soils and river sediments. The report concluded that “current conditions indicate that there are no apparent completed human exposure pathways at the [Quanta property]” (NJDOHSS, 2002).

Although site-specific air data were not available for review by NJDOHSS for the assessment, “general concerns regarding odors at the Site may suggest a localized potential air pathway, especially during heavy construction and/or remediation activities which disturb onsite soils and river sediments.” Additionally, these activities were described as possibly producing fugitive dust exposures for the nearby community. No data were available that established a completed exposure pathway to nearby human populations. Although data were limited, results of air and soil sample data from the Palisades Child Care Center, on the 115 River Road property, did not indicate a health concern (NJDOHSS, 2002).

### **Block 93 and River Road Areas**

**2004 Preliminary Assessment, Heagney and Frola Properties.** A Preliminary Assessment for Block 93, Lots 1, 2, and 3 – the 2.63-acre area between Old River Road and River Road – was conducted in 2004 (OBG, 2004). The assessment included site visits, a review of historical documents and property deeds, interviews with property owners, a review of regulatory agency documents, and an evaluation of other information obtained during the assessment process. The Preliminary Assessment summarized previous investigations and historical information, concluding that the three lots have been confirmed to contain or could contain contaminants in the fill layer above the New Jersey Residential and Non-Residential Soil Cleanup Criteria. No environmental samples were collected as part of the Preliminary Assessment. The property topographically upgradient of Block 93, Lots 1, 2, and 3, was described in the assessment as having an open leaking-UST case as a result of the release of an unknown quantity of xylene. As stated in EPA comments on the PSCR (June 30, 2006), the Preliminary Assessment was not subject to EPA review and approval; therefore, EPA does not endorse any of its conclusions (EPA, 2006b).

**RI Report.** Fieldwork at Block 93, Lots 1 and 2, in February and March 2005 for the RI conducted by Environmental Waste Management Associates, LLC (EWMA), included collection of 21 soil samples from five soil borings at four specific intervals (EWMA, 2005). Four samples were collected from each boring at 0–0.5 foot, 1.5–2 feet, 0.5 foot above the

groundwater table, 0.5 foot above the confining clay and silt layer, and 0.5 foot above the bedrock surface. One additional sample was collected from boring 3Y-3 between 2 and 2.5 feet bgs based on the shiny appearance of the fill material in this interval. Samples were submitted for laboratory analysis of Target Compound List/Target Analyte List compounds plus 30 peaks (TCL/TAL + 30) and ammonia. Base-neutral/acid extractables (BNAs) were detected at concentrations exceeding soil cleanup criteria (SCC) in all five borings. Metals (beryllium and arsenic) exceeded the SCC in a few samples collected from three of the borings. Benzene slightly exceeded the SCC in samples from two borings. A groundwater sample was collected from monitoring well MW-3Y, which was found to contain levels of benzene, benzo(a)pyrene, ammonia, and metals (aluminum, iron, manganese, and sodium) at concentrations exceeding the NJDEP groundwater quality standards (GWQS).

**Subsurface Investigation Report.** The September 2000 Subsurface Investigation Report was conducted to determine the geotechnical properties of subsurface material along the River Road corridor adjacent to the Quanta property (PMK Group, 2000). The investigation consisted of 38 test borings, from which samples were collected at closely spaced intervals. Samples were examined to determine lithology, moisture content, and Atterberg limits. The report concluded that observed settlement of the subsurface materials is likely near or at the maximum settlement expected for these materials.

### **Former Lever Brothers Property**

**Preliminary Assessment Report.** In the Preliminary Assessment Report conducted for Conopco, Inc., Langan researched past use and environmental activities for the former Lever Brothers property, including EPA/NJDEP permits held by Lever Brothers for activities and wastes produced onsite (Langan, 2003-2004). Lever Brothers also held an NJDEP Air Pollution Permit Number and Division of Water Resources Permit Number for stormwater runoff.

The report documents the discharges and remediation activities that had been recorded at the property in recent decades, including a 1981 underground spill from a fuel oil line that previously had been investigated and sampled by Dames & Moore. In 2001, Conopco, Inc., entered into the Voluntary Cleanup Program with the NJDEP, and the site was transferred to the Industrial Site Recovery Act (ISRA) program for further investigation.

**Site Investigation Reports.** This four-part report investigated the Areas of Concern (AOC) that were identified in the Preliminary Assessment Report (Langan, 2003-2004), primarily a Resource Conservation and Recovery Act (RCRA)-regulated former drum storage area, an area surrounding a former fuel line, and a waste disposal area. The report concluded that most of the AOCs required no further investigation because results of tests from the soil, groundwater, sediment, and surface water samples are indicative of the historical nature of local fill material. A No Further Action (NFA) and conditional NFA were issued by NJDEP in 2004 for many of the AOCs, although additional investigation was requested for some areas.

**RI Report and Remedial Action Work Plan.** Site investigation activities for an RI and for a Remedial Action Work Plan (RAWP) were performed by GZA GeoEnvironmental, Inc. (GZA) in 2004 during November and December and in 2005 during March, July, and August (GZA, 2006a). Activities included completion of 51 soil borings and collection of soil

samples, installation of temporary and permanent monitoring wells and groundwater sampling, and sampling of existing monitoring wells. Slug tests were conducted on some of the wells. Samples were analyzed for TPH, VOC+10, BN+15, priority pollutant metals (Ag, As, Be, Cd, Cr, Cu, Hg, Ni, Pb, Sb, Se, Tl, Zn), and PCBs. Soil and groundwater analytical results indicate the presence of VOCs, BNs, metals, and PCBs in concentrations exceeding NJDEP criteria.

**Pitch/Asphaltic Material Delineation/ RAWP Addendum.** GZA conducted an investigation at the former Lever Brothers property to delineate extent of pitch/asphalt (P/A) material in the subsurface and assess its consistency (GZA, 2006b). Three consistencies of P/A material were observed: a hard and brittle P/A material crushed and mixed with fill material, roofing material with layered fabric and roofing tar, and P/A material exhibiting a slightly plastic characteristic. Additionally, a moderately high-viscosity petroleum substance was observed.

**Indoor Air Quality Summary Letter, Building 9.** Indoor air samples were collected in Building 9 during March and October 2006. A total of seven indoor air samples were collected over a 24-hour period from the first and second floors of the building (GZA, 2007a). VOCs detected in the indoor air samples included 2-butanone, acetone, benzene, chloromethane, dichlorodifluoromethane, n-heptane, toluene, and trichlorofluoromethane. Concentrations of the detected VOCs were below NJDEP Indoor Air Screening Values. One background sample was collected during each of these sampling events. The detected concentrations in the indoor air sample collected in March were equal to or less than those in the background sample. The detected concentrations in the indoor air samples collected in October were greater than those in the background sample with the exception of benzene, chloromethane, and trichlorofluoromethane.

On the basis of the results of GZA work and considering the presence of the vapor barrier installed during construction of the building, it was determined that soil and groundwater impacts at the property were unlikely to affect human health during occupancy of Building 9. The majority of the compounds detected in indoor and outdoor air likely were influenced by compounds commonly found in consumer products and local atmospheric emissions.

**Supplemental Remedial Investigation Report.** GZA conducted supplemental remedial investigation activities from June 2006 to August 2007, as reported in the Supplemental Remedial Investigation Report submitted in November 2007 (GZA, 2007b). Activities described include inspection of sumps, installation of soil borings and monitoring wells, subslab and indoor air sampling, sediment sampling, elevation surveying, and test pitting along the embankment (results to be reported separately). The report proposes various remedial actions for AOCs on the property, including excavation, solidification/stabilization, product recovery, capping, monitored natural attenuation, subslab ventilation, and institutional controls.

### **Former Celotex Property**

**Remedial Investigation Report, Celotex Property.** A remedial investigation report was prepared for Edgewater Associates, the (former) owners of the Celotex property, for submittal to NJDEP in accordance with the New Jersey Administrative Code. A Memorandum of Agreement (Case #96-05-02-1722-24) had been signed in 1996 for

Edgewater Associates to perform remedial activities at the property. The property was divided into two portions for the purposes of the report, the northern portion (former Lustrelon, Inc.) and the southern portion (former Celotex Industrial Park). The work described in the report included delineation of previously identified metals, PAHs, TPH, and PCBs and the extent of fill material, and investigation of a gypsum board landfill, groundwater, and an existing AST on the property. The report concluded that the property had been filled during its long industrial history, and that metals, PAHs, and TPH typical of past operations on the property are present in the fill layer. The report concludes that the distribution of contamination is not consistent with a single or with multiple point sources (Enviro-Sciences, Inc., 1997).

**Remedial Investigation Report, Former Celotex Industrial Park.** EWMA prepared a remedial investigation report for Edgewater Enterprises, LLC, in 2000, describing remedial investigation activities implemented since August 1999, the date NJDEP issued an Administrative Consent Order enabling Edgewater Enterprises, LLC, to conduct all necessary remedial activities for the property. The report described investigative activities conducted at 13 AOCs and concluded that, other than the gypsum landfill and RCRA areas, the soil contamination at the property had been characterized sufficiently. The report proposed encapsulation of remaining soil contamination on the property (EWMA, 2000).

**Final Soil Remediation Investigation Report—Arsenic Area.** The Soil Remediation Investigation Report for the Arsenic Area determined that soil constituents of concern (COCs) in the upper fill material are arsenic, lead, and PAHs (Raviv, 2002). Secondary COCs identified in upper fill material included copper, mercury, selenium, and thallium. The report identified the High Concentration Arsenic Area (HCAA) as the area within the 1,000-parts-per-million (ppm) arsenic contour in soil, located on the southwestern portion of the property.

**Groundwater Remedial Investigation Report, Arsenic Area.** The groundwater remedial investigation report for the arsenic area describes activities conducted since the submittal of the July 2002 Soil Remediation Investigation Report, including soil sampling and installation and sampling of monitoring wells. The report concludes that high dissolved arsenic concentrations near the HCAA are oxidized and adsorbed by the soil matrix immediately downgradient, that conditions are stable and at equilibrium, and that no remedial measures for groundwater at the HCAA are necessary (Raviv, 2004). Relatively reducing conditions near the shoreline are sufficient to dissolve soil arsenic in this area and result in concentration concentrations of 10 to 100 ppb. The report calculated a maximum flux of 2.2 pounds per year of dissolved arsenic into the Hudson River, which is “100 times lower than the flux that would cause an exceedance of the most stringent applicable surface water quality criteria” (Raviv, 2004).

**Coal Tar Remedial Investigation Report—700 Building and Coal Tar Delineation Limits, Building 700 Area and South.** To address concerns that the coal tar plume extended into the footprint of proposed Building 700, EWMA conducted investigations to delineate the plume by locating soil borings on a grid system coinciding with the alignment of structural columns designed for the construction of Building 700 (EWMA, 2003, 2004a).

**Supplemental Groundwater Report—Arsenic Area.** According to the Supplemental Groundwater Report, bedrock groundwater quality had not been affected by arsenic, and

the vertical extent of arsenic exceedances in the HCAA has been delineated (Raviv, 2005). High concentrations of dissolved arsenic migrate a limited distance downgradient due to arsenic immobilization mechanisms in the subsurface, and these conditions are stable and at equilibrium. Relatively reducing conditions near the shoreline facilitate the dissolution of arsenic in soil in this area; however this area is separate from the HCAA and its associated impacts.

**Coal Tar Delineation Report.** In response to concerns raised regarding the extent of the coal tar plume as defined by EWMA during the coal tar RI, Environ was retained to conduct additional delineation activities. A total of 29 soil borings along 10 soil boring lines were advanced from January 26 to February 3, 2006. Residual coal tar was visually identified in areas beyond the coal tar limit previously delineated by EWMA. The delineation activities could not be completed due to the presence of physical constraints (Environ, 2006a).

**Supplemental Coal Tar Delineation Report.** Delineation activities, consisting of the advancement of 21 soil borings, were conducted between May 16 and June 24, 2006, to supplement the activities that Environ performed earlier in 2006 (Environ, 2006b). A “sweet chemical/ mothball” odor also was investigated. The coal-tar plume was visually identified in areas beyond the previously delineated EWMA coal tar limit (EWMA, 2004a).

#### 1.8.4 Background Conditions

For each of the properties discussed above, the ubiquitous presence of fill material has been documented to be a significant component of the near-surface soil setting. This is evidenced in numerous boring logs generated as part of investigations conducted throughout this portion of the Borough of Edgewater. Historical maps indicate that the banks of the Hudson River in this area were once dominated by tidal wetlands. During the mid-1800s fill was brought in to raise the topographic elevation to develop rail lines and industry along the River. In addition, as part of redevelopment activities in the area, fill material has been imported to further raise the land elevation.

The NJDEP Land Use Management Division and the New Jersey Geologic Survey have mapped the Site and surrounding areas as “Historic Fill” as part of the requirements set forth in the “Brownfield and Contaminated Site Remediation Act” (NJSA 58:10B-1 *et seq.*) (shown in Figure 1-5). The Historic Fill is known to contain significant quantities of coal, coal ash, wood ash, cinders, and slag. As a result, concentrations of PAHs and metals are detected above regulatory cleanup criteria. Although some of these constituents are present at OU1 as a result of former industrial activities, the fill material also contributes to the presence of PAHs and metals in soil and groundwater.

Since neither NJDEP (N.J.A.C. 7:26E-1.13(b)(2)(vii)(2) and 7:26E-3.10) nor EPA (2002b) require soil and groundwater cleanup below background concentrations, being able to differentiate impacts to media that represent background conditions from impacts that may have resulted from process operations is important.

## SECTION 2

# Investigation Summary

---

The following sections outline the objectives and procedures for the work that was performed in accordance with the RI/FS Work Plan and Addenda, and other activities listed in Section 1.5, with the exception of work that is currently being performed as part of the SRI and has not yet been completed.

## 2.1 Data Quality Objectives

### 2.1.1 RI/FS Work Plan

The RI/FS Work Plan, which EPA approved on May 2, 2005, identified the following specific OU1 data needs relative to the DQOs (Parsons, 2005):

- Delineation of LNAPL and DNAPL in the Upland Area (OU1)
- Delineation of contaminants in surface and subsurface soils
- Delineation of dissolved contaminants in groundwater zones (including the lower sand unit below the confining unit)
- Evaluation of indoor air
- Identification and evaluation of artificial conduits (such as underground pipes or sewer lines) on the Quanta property and on the 115 River Road and former Lever Brothers properties
- Evaluation of metals contamination and migration from the former metal-plating facility
- Delineation of PCBs potentially associated with oil storage facilities at the former Quanta Resources property

### 2.1.2 RI/FS Work Plan Addendum

In response to the data gaps identified and presented in the Draft PSCR following the completion of most of the work outlined in the original RI/FS Work Plan as well as data gaps identified by EPA in its comment letter dated June 30, 2006, an RI/FS Work Plan Addendum was prepared and submitted to EPA in July 2006 (CH2M HILL, 2006d). This submittal outlined specific DQOs and identified the following additional data needs:

- Refinement of the lateral and vertical extent of NAPL related to operations at the former Quanta Resources property and a determination of whether the NAPL is contiguous among points where it has been observed to date
- Extent of select coal tar-related VOCs and SVOCs relative to soil standards at several locations

- Extent of VOCs and SVOCs (benzene and naphthalene) in soil west of River Road, including defining the source and extent of elevated concentrations of benzene in the vicinity of EWMA soil boring 3Y-11
- Extent of selected metals exceeding proposed New Jersey Residential Soil Cleanup Criteria (New Jersey Administrative Code [NJAC], 1999) in soil (0 to 12 feet bgs) in the vicinity of borings SB-10, SB-11, and SB-13
- Further definition of the nature and extent of impacts at the Quanta property that are related to the former General Chemical Company acid plant to the north; specifically, how the impacts relate to the distribution of reddish-purple soil and elevated concentrations of arsenic and other RCRA metals that exceed New Jersey Residential Soil Standards
- Extent of PCBs in shallow soil (0– 4 feet bgs) along the western boundary of the Quanta property
- Potential presence of PCBs in the saturated deep sand deposit in the vicinity of boring SB-101DS
- Role of subsurface utilities and other subsurface features in the distribution and transport of coal tar and its constituents in the dissolved phase
- Better understanding of groundwater impacts and flow direction in the context of adjacent properties where releases have been documented

### **2.1.3 RI/FS Work Plan Addendum Nos. 2 and 4**

RI/FS Work Plan Addendum No. 2 was submitted to EPA for review in March 2007 (CH2M HILL, 2007a). CH2M HILL proposed to address data gaps through additional delineation of the extent of NAPL, installation of additional monitoring wells, and additional sampling of soil and groundwater. Following agency review of the Draft RI Report, RI/FS Work Plan Addendum No. 2 was updated and finalized in July 2008 as “RI/FS Work Plan Addendum No. 4 for an SRI (CH2M HILL, 2008a). The proposed objectives of the SRI are as follows:

- Determine the nature and extent of Site-related constituents and arsenic in the vicinity of Block 93 and the northwest portion of the former Lever Brother’s property and in the intersection of Gorge and River Roads
- Determine the nature and extent of NAPL in the northeastern portion of the former Lever Brother’s property (near MW-106A)
- Refine the nature and extent of NAPL behind and at the flanks of the wooden bulkhead
- Determine the dimensions of the wooden bulkhead to evaluate its role in limiting NAPL migration
- Supplement existing data to sufficiently characterize risk to human health at Block 93 Central and Block 93 South and for groundwater at the Site as a whole



- Begin collection of data to confirm stability of organic constituents and arsenic in groundwater at OU1
- Confirm distribution and mobility of arsenic in groundwater within and downgradient of suspected source zones at OU1
- Characterize groundwater flow paths and distribution and fate and transport of coal tar constituents (VOCs and PAHS) and arsenic across the groundwater/surface water transition zone(s) between OU1 and OU2

#### **2.1.4 RI/FS Work Plan Addendum No. 3**

On November 27, 2006, EPA requested that a characterization of arsenic and cinders be conducted. Subsequent submittals and conversations with EPA led to the submittal of the “Remedial Investigation/Feasibility Study Work Plan Addendum No. 3 and Field Sampling Plan for the Characterization of Cinder/Ash and Reddish-Purple Soils” (CH2M HILL, 2007d). After receiving EPA approval of the work plan on May 4, 2007, fieldwork was begun May 31 and completed June 7, 2007. The primary objective of these supplemental RI/FS activities was to provide EPA and NJDEP, by means of a balanced weight-of-evidence approach, with a defensible conclusion that the investigations into the nature, extent, and origin of the cinder/ash and reddish-purple soils and the potential for these materials to act as a source of arsenic (and other potential constituents) to groundwater the activities have been thorough and complete and have provided all the information that is needed with regard to remedial design. Secondly, the objective of this work was to confirm the assertions presented in the “Summary of the OU1 Supplemental Investigation Metals Soil Sampling and Evaluation of Cinder/Ash and Pyrite Impacted Soils Technical Memorandum” (CH2M HILL, 2007b).

#### **2.1.5 Other Activities**

In addition to the RI data-collection activities performed in accordance with the RI/FS Work Plan and the two approved RI/FS Work Plan addendums, activities performed in response to EPA requests and discussed in this RI Report include the following:

##### **115 River Road Vapor Intrusion Evaluations**

In response to a request by EPA and NJDEP, a work plan was prepared and submitted proposing evaluation of potential vapor intrusion pathways at the former Spencer-Kellogg building, located along the southern boundary of the Quanta property, to be conducted as part of the RI/FS (CH2M HILL, 2006e). As part of this investigation, the work plan identified the following data needs:

- Identify potentially complete vapor intrusion pathways into the 115 River Road building, if any, and identify appropriate actions to address potentially complete vapor intrusion pathways, if necessary
- Perform work based on a 3-Tier Sampling Rationale, where the first phase quickly identifies a potential pathway at the Site, the second compares measured or estimated concentrations of constituents in various media to risk-based screening values, and the third conducts a more detailed evaluation of the vapor intrusion pathway, typically to involve direct measurement of vapor intrusion potential.

### **115 River Road Product Inventory Survey**

A complete building survey was conducted in September 2006 to identify within the buildings the storage and use of chemicals that could emit VOCs, which could be interferences in indoor air samples.

### **115 River Road Building Pressurization Survey**

A pressurization survey was conducted to identify indoor spaces with significant depressurization, which could provide a driving force for indoor vapor intrusion.

### **Jono's Restaurant Building Vapor Intrusion Evaluation**

In response to a request by EPA and NJDEP, an evaluation of the potential for indoor vapor intrusion pathways near the Jono's Restaurant building on Block 93 North was conducted in April 2007. That evaluation summarized the results of previous investigations that had detected VOCs and SVOCs in soil and groundwater at Block 93 and presented the results from the survey of the building (CH2M HILL, 2007g). The overall assessment in April 2007 was that potential vapor intrusion pathways were not present in the building. Groundwater sampling conducted in June 2007 confirmed the overall assessment provided in the April 2007 evaluation, that a potential vapor intrusion pathway is not present in the building (CH2M HILL, 2007k).

### **Seasonal Standing Water Sampling**

Potential ecological risk was evaluated using the results of sampling conducted at each of four locations on the Quanta property where accumulation of standing water is common during wetter times of the year. The results of this evaluation are presented in the Screening-Level Ecological Risk Assessment (SLERA) for OU1 and discussed in Section 7 of this report.

### **NAPL Recovery Testing**

The fieldwork described below was performed in general accordance with the December 2006 Scope of Work that CH2M HILL submitted to EPA. As stated in the Scope of Work, the fieldwork was designed to remove NAPL from monitoring wells with the thickest NAPL accumulation (as observed during 2005–2006 RI activities). Accumulated NAPL was pumped from monitoring wells in December 2006 and July 2007, and subsequent measurements were used to test the removal and subsequent rebound of accumulated NAPL in select monitoring wells. The objectives of this work were as follows:

- Recover NAPL from the Site
- Collect additional data on the recoverability and mobility of NAPL at the select monitoring wells
- Evaluate the behavior of measurable NAPL in the monitoring wells over time

CH2M HILL reported the results of the testing to EPA in the “Non-Aqueous Phase Liquid (NAPL) Recovery Testing Results – Quanta Resources Superfund Site” technical memorandum, submitted on November 6, 2007 (CH2M HILL, 2007l).

### **Arsenic Dust Evaluation**

A letter from EPA dated November 16, 2006, expressed concerns about potential human exposure to arsenic from windblown dust. EPA requested that an ambient air monitoring program be established and five perimeter air samplers be installed. The “Evaluation of Potential Air Exposure Pathways at the Quanta Resources Site, Edgewater, New Jersey” technical memorandum (CH2M HILL, 2006f) was submitted in December 2006 providing additional technical evaluation of the air pathway; it concluded that ambient air sampling was not warranted at that time.

Later, soil sampling was performed to estimate concentrations of arsenic in the surface soil and to update the results from the previous evaluation. The previous evaluation estimated a risk-based screening level in soil based on potential inhalation exposure using both residential exposure assumptions and a particulate emission factor calculated with conservative default assumptions. As recommended (CH2M HILL, 2006f), additional characterization was performed to develop a Site-specific estimate of potential dust emissions from surface soil at the Site. This Site-specific estimate of potential dust emissions was used to calculate a Site-specific screening level in soil based on potential inhalation exposure under residential exposure assumptions. The approach for developing this Site-specific estimate of potential dust emissions was based on the procedures in “Rapid Assessment of Exposure to Particulate Emissions from Surface Contamination” (Cowherd et al., 1985).

### **Cultural Resources Survey**

A Stage 1A Literature Search and Sensitivity Study (Phase IA Cultural Resources Survey) was conducted to evaluate the Site and immediate surroundings for the presence of known or potential historical, architectural, and/or archeological resources and rate the sensitivity of the Site as high, medium, or low pursuant to Section 106 of the National Historic Preservation Act, and its implementing regulations, 36 CFR Part 800.

### **Treatability Study Sample Collection**

In accordance with the “In Situ Chemical Oxidation Treatability Study Work Plan” (CH2M HILL, 2007f), samples were collected from three locations on the Quanta property for the bench-scale treatability testing of in-situ chemical oxidation technology. The results of the treatability testing will be provided to EPA in the FS Report for OU1; however, observations made during sampling are included in this RI Report.

## **2.2 Site Surveying**

### **2.2.1 Site Survey**

Surveying tasks were completed by a New Jersey-licensed surveying subcontractor, Vargo Associates, of Franklinville, New Jersey. The purpose of the survey was to document in a standardized and reproducible manner the lateral locations and elevations of soil borings, monitoring wells, etc. from the RI/FS activities in the OU1 study area. Vargo also completed documentation of the monitoring well surveying, as required by NJDEP. Prior to the SI field activities, Vargo surveyed the locations of two 1,000-gallon ammonia USTs on Block 93, Lot 3, on the basis of the locations as depicted on historical Sanborn® fire insurance maps.

## 2.2.2 Subsurface Utility Survey

The New Jersey One Call utility mark-out service was called prior to the commencement of the subsurface investigation activities. The New Jersey One Call service notified Time Warner Cable, Verizon, United Water New Jersey, PSE&G Gas Division, and Bergen County Department of Public Works. In addition, private geophysical surveys were performed in selected areas, as described below, to augment the New Jersey One Call mark-outs. The purpose of the utility mark-outs was to assess whether subsurface obstructions were present where intrusive RI/FS field activities would take place. Subsurface utility surveys were performed for two field events: the RI soil sampling and well installation during fall and winter 2005 and the SI during fall and winter 2006.

For the 2005 phase of the RI activities, Summit Drilling of Bridgewater, New Jersey, performed a geophysical survey for utility clearance. The survey was conducted in the vicinity of soil borings SB-12, SB-14, and SB-15 in River and Gorge roads, as well as in the vicinity of each of the monitoring wells and soil borings on the former Lever Brothers and 115 River Road properties. The subsurface geophysical survey was performed using a Utilivac VE75 ground-penetrating radar and a RD4000DF receiver pipe and cable locator. In the event a subsurface anomaly was detected, the location was moved to an area where the anomaly was not observed (generally, within 5 to 10 feet of the previously proposed location). Locations of subsurface anomalies and the “cleared” boring locations (based on the observations during the subsurface utility survey) were marked with spray paint on the ground surface. No reports or maps were generated by Summit Drilling pertaining to the subsurface utility survey.

Enviroscan of Lancaster, Pennsylvania, conducted a geophysical survey prior to implementation of the SI. The survey was conducted in the vicinity of each of the proposed subsurface investigation locations (conventional soil borings and TarGOST® investigation locations) on the former Lever Brothers, former Celotex, and 115 River Road properties and Block 93. Enviroscan also performed a geophysical survey around the surveyed location of the two 1,000-gallon ammonia USTs depicted in historical Sanborn® fire insurance maps. Enviroscan found no evidence of USTs in the surveyed area. Enviroscan used a Geophysical Software Systems, Inc. (GSSI), Surface Interface Radar ground-penetrating radar unit fitted with 400- and 500-MHz antennae, a Fisher® TW-6 metal detector, and a Radiodetection® RD 4000 cable-avoidance tool during their geophysical survey. Locations of subsurface anomalies and the “cleared” boring locations (based on the observations during the subsurface utility survey) were marked with spray paint on the ground surface. No reports or maps were generated by Enviroscan pertaining to the subsurface utility survey.

In addition, as part of the access agreements required for performing work on the properties, plans of available subsurface utilities on each of the properties other than the Quanta property were obtained and reviewed in the context of the geophysical survey results.

## 2.2.3 Floodplain Delineation

The 100-year floodplain elevation of 10 feet above sea level has been delineated and is shown in Figure 2-1 as Zone AE. Most of the Site is within the 100-year floodplain, indicating that nearly all of OU1 has at least a 1 percent chance of being flooded each year.

A small portion of Block 93 is also located in the 500-year floodplain area. The above information was prepared through use of the FEMA (2005) Flood Insurance Rate Map.

## **2.2.4 Cultural Resources Survey**

A Stage IA Literature Search and Sensitivity Analysis (also known as a Stage IA Cultural Resources Survey) for OU1 was conducted in accordance with the January 2007 Work Plan as approved by EPA on February 26, 2007. The analysis was performed by John Milner Associates, Inc., of West Chester, Pennsylvania (JMA), and consisted of archival research, upland field reconnaissance, and Geographic Information System (GIS) analysis. The following subsections describing work performed and conclusions of the survey duplicate the material presented in the “Stage IA Cultural Resources Survey Report” submitted to EPA on May 30, 2007 (JMA, 2007). The conclusions of the survey are presented in Section 3.5 of this RI Report.

### **Archival Research**

Primary and secondary sources were examined to document the environmental setting of the Project Area, develop historic contexts for understanding potential cultural resources in the Project Area, and assess the likelihood that the Project Area contains archeological resources.

These sources included both written and cartographic documents relating to past and present environmental conditions and human occupation of the region. Information concerning previously recorded archeological sites in the vicinity of the project area was acquired from the site files of the New Jersey State Museum (NJSM) and New Jersey Historic Preservation Office (HPO). JMA personnel reviewed national, state, and local inventories of previously recorded architectural and historical resources to identify any historically significant properties near the Project Area. This review included checks of the National Register of Historic Places, the New Jersey Register of Historic Places, and the Building-Structure Inventory maintained by HPO (see Section 4.1).

An examination of the files of the New Jersey HPO did not reveal any record of previously recorded archeological sites within 1 mile of the Project. When contacted as part of the literature search, NJSM advised that no known archeological resources were located within a 1-mile radius of the Project. The files of the New Jersey HPO contained information on several previously inventoried historical and architectural resources near the Project Area. Only one, the Spencer Kellogg and Sons, Inc., Pier and Transit Shed, is mapped in the Project Area, but this resource is no longer extant.

### **Upland Field Reconnaissance**

JMA personnel conducted a field reconnaissance of the Project Area on April 2, 2007. The purpose of the field reconnaissance was to assess the degree of previous ground disturbance, evaluate the potential for the Project Area to contain archeological resources, identify any potentially significant aboveground cultural resources in the immediate vicinity of the Project Area, and inspect the present condition of previously recorded cultural resources in the Project Area. Documentation included recording observations and photographing significant or informative landscape features. As a component of the site

reconnaissance, previously recorded historical properties in and adjacent to the Project Area were examined and photographed to document present conditions.

### **GIS Analysis**

An archeological sensitivity study was conducted for the existing project area using GIS. Both historic and prehistoric archeological sources were analyzed in this study. The basis for this study was a collection of 30 historic maps, 11 Sanborn® fire insurance maps, and eight aerial photos depicting the study area. These data sources' dates ranged from 1776 to 2006. Archival data derived from the New Jersey HPO also is included in this study.

The potential archeological sensitivity for prehistoric resources is derived from known site locations and a reconstruction of the Project Area geomorphic landforms. Historical and geological data sources provide the information necessary to assign sensitivity strata across the Project Area.

The labels "High," "Medium," "Low," and "No Sensitivity" are assigned to segments of the Project Area based on the sensitivity analysis. Areas indicated as high sensitivity carry the greatest likelihood of containing prehistoric archeological sites and/or artifacts. Medium- and low-sensitivity areas carry progressively less probability of containing prehistoric material, though the possibility still exists. No sensitivity is generally a "Special Case" scenario. The absence of prehistoric archeological sensitivity can be assumed only if the extent (both horizontal and vertical) of recent disturbance can be documented adequately. Ground disturbance must have occurred to such an extent as to render unlikely the survival of potentially significant archeological resources. All levels of sensitivity, excluding the special case of no sensitivity, require some level of field investigation.

Various types of models are used to determine the prehistoric archeological sensitivity of landforms within a project area. The type of analysis used depends on many factors, such as the size and location of the project area and the quality of data of previously recorded archeological sites. The model used for this study accounted for the developmental history of the project area landforms and the extent to which 130 years of industrial activity had affected them. Historical maps, engineering reports, and soils maps are used in the analysis of the study area's natural development.

Historic archeological sensitivity is derived from the analysis of the changing built environment over time. The location of all recorded historical residential, industrial, and commercial activity is compiled and cross-referenced to all areas of ground disturbance over time. Areas that demonstrate historical activities but do not appear to be disturbed are considered sensitive for historical archeological resources. The extent of disturbance and intensity of historic activities are weighted, qualitatively or quantitatively depending on the model used, to determine the level of sensitivity. For this project, high amounts of industrial disturbance and low degrees of potentially significant historical activity lends to a simple qualitative model.

## **2.3 Investigation Procedures**

The following subsections describe in detail the procedures for advancement of soil borings with subsequent soil sampling, well installation with subsequent groundwater sampling,

assessment of preferential pathways, and other activities conducted during implementation of the work plans described in Sections 1.1 to 1.5.

### 2.3.1 Boring Advancement

Soil borings were installed during RI activities to depths ranging from 9 to 62 feet bgs to collect representative soil samples, characterize the subsurface geological conditions, and evaluate the nature and extent of contamination. Fifty-four soil borings were advanced during initial RI activities, of which 36 were completed subsequently as monitoring wells (including one replacement monitoring well, MW-104R). An additional 31 soil borings were advanced during SI activities, of which nine borings were intended to address data gap issues and further delineate constituents.

Twenty-two soil borings were advanced to confirm the results of the TarGOST® delineation. These confirmatory borings are discussed in more detail in Section 2.2.4. Soil borings were advanced at nine additional locations during the characterization of cinder/ash and reddish-purple soils. The locations of all soil borings are shown in Figure 2-2. All RI soil borings are summarized in Table 2-1.

Prior to drilling activities, Vargo (a New Jersey-licensed survey firm) surveyed the proposed sample locations by instrument. Summit Drilling and SGS Environmental Services, Inc., of West Creek, New Jersey (SGS), performed the soil borings and monitoring well installations during the initial RI activities. SGS performed the soil borings and the direct-push drilling to advance the TarGOST® probe during SI activities, and the soil borings during the characterization of cinder/ash and reddish-purple soils in June 2007. One of three drilling methods—hollow-stem auger (HSA), air/mud rotary, and Geoprobe® (direct-push)—was used to advance soil borings. Borings were advanced from the ground surface to auger refusal or to a depth specified in the applicable work plan. When drilling conditions permitted, soil samples were collected continuously at 2-foot intervals from the ground surface to the desired depth using either a clean, 2-foot-long, stainless-steel, split spoon or a Geoprobe® direct-push Macro-Core® sampler with a disposable acetate liner. During the characterization of cinder/ash and reddish-purple soils, soil samples were collected continuously at 5-foot intervals. Soil samples were classified by the onsite CH2M HILL geologist in general accordance with the Unified Soil Classification System using the procedures described by ASTM (2000). Soil samples were screened using a photoionization detector (PID). Soil logs containing information about lithology, visual evidence of impacts, PID readings, and general drilling conditions were maintained for each soil boring and are presented in Appendix B.

Subsurface obstructions were encountered while using the HSA rig to advance soil borings SB-2, SB-3, SB-7, SB-9, SB-16, and SB-18. Soil borings SB-2 and SB-3 are in an area with remnant concrete AST pads with steel-reinforced structural support. Soil borings SB-7 and SB-9 are in the north-central and northwestern portions of the Quanta property, respectively, and encountered subsurface obstructions from about 2.5 to 8.0 feet bgs. Similar obstructions were encountered while attempting to advance soil borings SB-16 and SB-18 on the former Lever Brothers property. In each of these instances, several unsuccessful attempts were made to auger through the obstructions prior to use of an air rotary drill rig. The air rotary drill rig was used in place of HSA drilling to advance pilot holes past the obstructions at SB-2, SB-3, SB-7, SB-9, SB-16, and SB-18. Continuous soil sampling was not possible

during air rotary drilling. Once the obstruction was cleared, the HSA drilling method was used to complete the soil borings to the depths specified in the RI/FS Work Plan.

During the TarGOST® component of the SI, air rotary drilling was used to pilot each borehole on the former Celotex property, except for confirmatory sample locations TL 17-05, TL 18.5-1.5, and TL 19.5-0.5, as well as TarGOST® locations TL 16.5-02 and TL 18-01. Air rotary drilling was used because previous subsurface investigations revealed a significant thickness of bouldery fill throughout the area of the proposed drilling locations on this property. At each of these locations, the air rotary rig was used to drill through the bouldery fill. Each pilot borehole was backfilled with clean sand and marked so that the pilot hole could be located subsequently and the TarGOST® tool advanced using direct-push drilling techniques. Pilot holes also were advanced through the top few feet of gravelly fill and/or reinforced concrete with an air rotary drill rig for many TarGOST® borings, to minimize the possibility of damaging the TarGOST® probe.

All the initial RI soil borings were advanced using HSA drilling, with the exception of SB-1, SB-4, SB-12, SB-14, SB-15, and SB-17, all of which were advanced using a Model 6600 truck-mounted Geoprobe® rig. All soil borings advanced during the SI activities were advanced using a Model 6010 track-mounted Geoprobe® rig. A subsurface utility survey was performed in the vicinity of soil borings SB-12, SB-14, and SB-15 and all SI soil borings to augment the New Jersey One Call Service. Subsurface anomalies were identified during this survey, and as a result, SB-12, SB-14, and SB-15 were cleared with a pressurized air knife to a depth of approximately 5 feet bgs prior to advancing these borings with the Geoprobe®.

During the characterization of cinder/ash and reddish-purple soils, nine soil borings (SB-28 through SB-31, SB-34C, SB-35A, and SB-36 through SB-38) were advanced at a minimum to a depth that corresponded with the contact between the fill unit and the native deposits at each location. The one exception to this was at SB-34, where after eight attempts resulted in shallow refusal, a maximum depth of only 5 feet was achieved owing to debris from building demolition.

Upon completion of the borings, soil borings that were not converted into monitoring wells were backfilled with hydrated bentonite chips. The top 6 inches of each abandoned boring was completed with material similar to the surrounding surface (e.g., asphalt, concrete, or gravel). Soil boring SB-25 was pressure-grouted with cement-bentonite slurry to prevent vertical migration and maintain natural hydraulic conditions because it was advanced below the silty-clay confining unit.

### **2.3.2 Soil Sampling**

When field conditions permitted (i.e., when a sampler could be advanced or recovery was sufficient), soil samples were collected for laboratory analysis from the sample intervals specified in the applicable RI/FS Work Plan or RI/FS Work Plan Addendum. The results of the soil samples collected as part of the RI, SI, and characterization of cinder/ash and reddish-purple soils are summarized in Table 2-2 along with additional soil samples collected during previous investigations that were evaluated as part of the RI. Soil boring logs are presented in Appendix B.

During the initial RI activities and subsequent SI and characterization of cinder/ash and reddish-purple soils activities, 203 soil samples were collected and analyzed. During the



initial RI activities, 126 soil samples were collected for laboratory analysis and were shipped by overnight courier to Lancaster Laboratories in Lancaster, Pennsylvania (NJDEP certification number PA011), under executed chain-of-custody forms. Fifty-nine soil samples were collected for laboratory analysis during SI activities and were shipped via overnight courier to Accutest Laboratory under executed chain-of-custody forms. During the characterization of cinder/ash and reddish-purple soils, 18 soil samples and one slag sample were collected and shipped to Accutest Laboratory and/or Mineralogy, Inc., of Tulsa, Oklahoma under executed chain-of-custody forms. During the characterization of cinder/ash and reddish-purple soils, photographs were taken to further document the characteristics of the subsurface soils, especially the soils that were targeted and collected for analytical sampling. Table 2-2 presents a summary of the parameters for which samples were analyzed. Laboratory analytical results from the initial RI and SI activities are summarized in Appendix C and discussed in Section 4. Copies of the complete laboratory analytical reports for all analytical data collected during the RI are provided as Appendix D. The results of the characterization of cinder/ash and reddish-purple soils are discussed in Section 4.

Shelby tube undisturbed soil samples were collected from soil borings SB-101DS, SB-103DS, SB-114B, and SB-121B at depths of 32 to 34 feet bgs, 22 to 24 feet bgs, 27 to 29 feet bgs, and 24 to 26 feet bgs, respectively. The Shelby tube samples were analyzed by SJB Services, Inc. of Balston Spa, New York (SJB), for hydraulic conductivity by ASTM Method D5084-03. The lithology of the sampled intervals from SB-101DS and SB-103DS described by SJB consisted of silty clay and the lithology of the sampled intervals from SB-114B and SB-121B consisted of brown silt, some clay, with fine sand. SJB lithology classifications are generally consistent with the field observations of the CH2M HILL field geologist. The hydraulic conductivity data are discussed in Section 3.4.3. A copy of the laboratory reports for these analyses is included in Appendix D.

During the characterization of cinder/ash and reddish-purple soils, the recovered soil was inspected carefully for the presence of cinders, slag, and reddish-purple soils (targeted materials), which were the primary subjects of the investigation. If necessary, a spray bottle containing deionized water was used to wash loose material from larger objects to better identify the presence of cinders and slag. When the targeted materials were present, only the interval of soil visually identified to contain the targeted materials was included in the sample interval to assure mineralogical and analytical results were not biased by the inclusion of soils from adjacent intervals. When a soil interval containing alone or more of the targeted materials was observed, the entire soil interval containing these materials was placed in a disposable aluminum pan, thoroughly homogenized, and transferred to the required sample containers for the analyses specified in the “Remedial Investigation/Feasibility Study Work Plan Addendum No. 3 and Field Sampling Plan for the Characterization of Cinder/Ash and Reddish-Purple Soils” (CH2M HILL, 2007d).

In accordance with the work plan addendum, intervals containing the targeted materials that spanned both the vadose and saturated soil zones were divided, and separate samples were collected from the saturated and unsaturated zones. Sampled soil intervals from both zones were analyzed for EPA SW-846 TAL metals using EPA Methods 6010B and 7470A, and total organic carbon (TOC) content using EPA Method SW846 9060. In addition, a portion of each homogenized sample was packaged for further analysis using X-ray

diffraction (XRD) (bulk and clay fraction) to provide a semiquantitative assessment of each of the types of materials mineralogy and thin-section petrography to identify and characterize the fabric and texture of these mineral matrices. Where possible, thin-section petrography samples were taken by removing a portion of the soil core (approximately 3 inches in length) from within the sampled interval prior to the core being homogenized and packaging the intact core in plastic wrap (such as Saran Wrap), placing it in a jar, and shipping it to the laboratory. The cohesiveness of the sampled soils allowed for this method to be used for only the three samples collected at SB-36 (0.8 to 1.2 feet bgs, 1.2 to 2.2 feet bgs, and 3.2 to 5.2 feet bgs). The leachate from unsaturated soil samples also were analyzed for TAL metals via EPA Methods 1312/6010B and 7470A using the Synthetic Precipitation Leachate Procedure (SPLP). To address data gaps identified in the “Proposed Scope of Work – Supplemental Data Gap Sampling” (CH2M HILL, 2007a), three soil samples were sent to Accutest Laboratory for the analysis of SVOCs using EPA Method 8270. One sample was analyzed for VOCs by EPA Method 8260.

### **2.3.3 Permanent Monitoring Well Installation and Sampling**

#### **Shallow Monitoring Wells**

Nineteen soil borings were converted to permanent shallow groundwater-monitoring wells with depths ranging from 9 to 30 feet bgs (labeled “A”), along with the replacement monitoring well MW-104R to augment the existing monitoring well network. These monitoring wells were drilled using a nominal 6-inch-inner-diameter (ID) HSA and constructed with a 4-inch-diameter, Schedule 40 polyvinyl chloride (PVC) riser, and 10 feet of 0.020-inch Schedule 40 PVC screen. Thirteen shallow groundwater “B” wells were installed at the base of the shallow overburden hydrostratigraphic unit. The B wells were constructed in the same manner as above, with the addition of a 2-foot sump of threaded flush-jointed PVC riser pipe attached to the bottom of the screen. The 2-foot-long sump was added for the purpose of capturing NAPL in the shallow unconsolidated unit.

Characteristics of permanent monitoring wells are summarized in Table 2-3. Figure 2-3 depicts the location of each monitoring well included in the RI, SI, and characterization of cinder/ash and reddish-purple soils. Monitoring well construction logs are presented in Appendix E.

#### **Deep Monitoring Wells**

Four deep groundwater “DS” wells were installed to depths ranging from 29 to 62 feet bgs by advancing an 8 1/4-inch-ID HSA to a depth of about 5 feet into the confining unit. A 6-inch-ID carbon steel isolation casing was then installed through the augers into the borehole and grouted in place using cement-bentonite grout. After the grout had been allowed to cure overnight, mud rotary drilling using a nominal 4-inch-diameter borehole was advanced from the bottom of the isolation casing to the top of the underlying bedrock. Mud rotary drilling was used in place of HSA drilling to prevent the borehole from collapsing. Once the final depth was reached, the water was pumped into the borehole to remove excess drilling mud from the bottom of the boring. Deep monitoring wells were constructed with 2-inch-ID, Schedule 40 PVC riser pipe, with 10 feet of 0.020-inch Schedule 40 wire-wrapped PVC screen.

## Monitoring Well Development

The newly installed shallow and deep monitoring wells were developed from September 12 to September 22, 2005; on November 14, 2005; from November 19 to November 22, 2005; on November 29 and 30, 2005; on January 28, 2006; and on February 15, 2006. All wells were developed using surge-and-purge methodology in accordance with EPA (1992b) guidelines. During development, water quality parameters (turbidity, temperature, dissolved oxygen, pH, and conductivity) were measured using a Horiba® U-22 water quality meter or equivalent Yellow Springs Instruments® (YSI) meter. The water level in the well was measured regularly with a water-level indicator. Development continued until water quality parameters stabilized or until the monitoring well was pumped dry three times over a 3-day period. Monitoring well completion diagrams, NJDEP Form Bs, and well development logs are included as Appendix E. Development water was contained in 55-gallon drums and was staged on the Quanta property for future offsite disposal. If NAPL was observed in the purge water during development, water quality parameters were not measured until NAPL was no longer observed.

## Groundwater Sampling

In accordance with the RI/FS Work Plan, 1 year of quarterly groundwater sampling was performed at the Site. The first round of sampling took place in November and December of 2005, the second event took place in February and March of 2006, the third event took place in May 2006, and the fourth event took place in August 2006. An additional groundwater-sampling event was conducted as part of the SI in October. Groundwater samples were collected in general accordance with EPA (1998a) low-flow procedures. Table 2-4 lists each well that was sampled during each of these five events.

During the first round of groundwater sampling, 8 existing monitoring wells and 29 newly installed monitoring wells were sampled. Of the 37 wells sampled, 20 were on the Quanta property, 4 were on Block 93, 10 were on the former Lever Brothers property, and 3 were on the 115 River Road property. Sampling of two existing wells (MW-104 and MW-110) and one newly installed well (replacement well MW-104R) on the Quanta property was not called for in the RI/FS Work Plan. Sampling of wells on the former Celotex property did not occur because the access agreement with the property owners had not been finalized.

During the second round of groundwater sampling, 49 monitoring wells were sampled, including 34 of the 37 wells sampled during the first round of sampling. Exceptions included MW-108, for which access was blocked; MW-102A, which was impacted heavily with NAPL; and MW-122A, which was replaced by a well farther south. Six additional newly installed wells were sampled—four on the 115 River Road property and two on the former Lever Brothers property. Nine wells on the former Celotex property also were sampled.

Prior to the third round of sampling, it was determined that monitoring wells with NAPL present were not to be sampled. This decision excluded 13 wells—11 on the Quanta property, one on the former Lever Brothers property, and one on the 115 River Road property. Wells MW-122A and MW-108 were included in this round and in round four. During the third round, 39 wells were sampled.

During the fourth round of sampling, 37 of the 39 monitoring wells sampled during the previous round were sampled, with two exceptions: MW-105A and MW-119A were not sampled because of the presence of NAPL. Five additional wells were sampled on the former Lever Brothers property.

The SI groundwater-sampling event was conducted to further delineate the nature and extent of arsenic in groundwater at OU1. The results of this investigation also were used to discriminate groundwater impacts related to the Site and those impacts from historical manufacturing operations at the former Lever Brother's property. During the SI event a total of 24 monitoring wells were sampled. On the former Celotex property, 16 wells were sampled, 12 of which had not been sampled previously. Five wells were sampled on the former Lever Brothers property, two of which had not been sampled previously. One well on each of the other three properties—the Quanta property, 115 River Road, and Block 93—was also sampled.

### **Groundwater-Sampling Equipment and Procedures**

Groundwater purging and sampling were conducted in accordance with the techniques described in Appendix A (Field Sampling Plan) of the original RI/FS Work Plan (Parsons, 2005). After a comprehensive round of water level measurements was performed as described in Section 2.2.6 and prior to sampling, the monitoring wells were purged using low-flow-sampling techniques (EPA, 1998a) to minimize turbidity and to ensure the samples were representative of formation conditions.

For the first round, sampling was performed using a clean 2-inch-diameter stainless steel Grundfos® submersible, RediFlo2® pump, and dedicated 1/2-inch-ID Teflon®-lined polyethylene tubing. The pumping rate during purging was maintained at a range of 300 to 600 mL/min. For the second, third, and fourth rounds and for the SI event, the sampling equipment was changed to SamplePro® (from QED Environmental Systems, Inc., of Ann Arbor, Michigan) portable micropurge bladder pumps with dedicated 1/4-inch-outer diameter (OD) Teflon® tubing and Teflon® bladders. This change was made to comply with necessary decontamination procedures. The QED bladder pumps can be decontaminated more thoroughly because they are constructed in a way that facilitates their complete disassembly. Grundfos® pumps have lead wires that connect the pump in the well to the control box at the ground surface. During the first round of sampling, a considerable amount of time was spent decontaminating these wires when they came in contact with NAPL. This effort was eliminated with the use of QED bladder pumps, which do not have lead wires. The pumping rate during purging was still maintained with the QED bladder pumps at a range of 300 to 600 mL/min.

Water quality parameters and depth-to-water readings were measured regularly throughout the purging of each well. The field water quality parameters that were measured included pH, specific conductance, dissolved oxygen, oxidation reduction potential, temperature, and turbidity. With the exception of turbidity, field chemistry parameters were measured using a Horiba® U-22 water quality meter during the first three rounds. During round four, the SI event, and the characterization of cinders and reddish-purple soils event, field chemistry parameters (except turbidity) were measured with a YSI 600XL water quality meter. Turbidity was measured for all five events using a LaMotte® 2020 turbidity meter. Other observations such as odor, appearance, and presence

of NAPL also were recorded during groundwater sampling. Table 2-5 shows the groundwater quality parameters that were measured during all five events.

Upon the stabilization of the water quality parameters, the purge rate was reduced to 200 mL/min, and a sample was collected and immediately placed in a cooler with ice. Decontamination procedures are provided in Section 2.3, and investigation-derived waste (IDW) management procedures are provided in Section 2.4.

### **Groundwater Sample Analytical Methods**

The analyses performed on each sample collected are shown in Table 2-4. Details regarding the required containers, preservatives, and holding times for groundwater samples are listed in the field sampling plan (Parsons, 2005).

Groundwater samples collected during the four rounds of quarterly sampling were analyzed for VOCs by EPA Method 8260, SVOCs by EPA Method 8270, PCBs by EPA Method 8082, and arsenic and lead by EPA Method 6010. Samples from selected wells were analyzed for pesticides by EPA Method 8081 and for ammonia by EPA Method 350.1. During the fourth round of sampling, samples from select wells were analyzed for arsenic III and arsenic V speciation by EPA Method 7063.

Groundwater samples collected during the SI event were analyzed for arsenic by EPA Method 6010 and any combination of the following analyses: ammonia by EPA Method 350.1, total Kjeldahl nitrogen (TKN) by Method 351.2, arsenic III and arsenic V by EPA Method 7063, methylated arsenic speciation by EPA Method 6800, and iron by EPA Method 6010.

Quality assurance/quality control (QA/QC) samples were collected in the frequency and the manner specified in the revised QAPP (CH2M HILL, 2006a). Samples were transported by overnight courier to the laboratory under standard chain-of-custody protocol. Lancaster Laboratories performed the analyses for sampling events one through three. Accutest Laboratories performed the analyses for event four and the SI event. The arsenic III and arsenic V speciation was performed by STL North Canton (NJDEP certification number OH001), and the methylated arsenic (dimethylated arsenite [DMA]/monomethylated arsenite [MMA]) speciation was performed by Applied Speciation and Consulting.

A summary of groundwater analytical results can be found in Appendix F. The analytical results are discussed in detail in Section 4.2.2.

### **Modification to Quarterly Groundwater Sampling**

Quarterly groundwater sampling events performed at the Site in accordance with the RI/FS Work Plan included the collection of groundwater samples from wells containing NAPL during the first and second rounds. In a letter to EPA dated May 5, 2006, CH2M HILL requested that sampling of wells where NAPL was detected consistently be discontinued and stated that this change in protocol would be adopted during the third quarterly groundwater sampling event that took place at the end of May 2006 (CH2M HILL, 2006i). Subsequent e-mail correspondence from EPA, received June 2, 2006, indicated that this change had not been approved and that further discussion was warranted before any approval to this modification would be granted.

In the letter to EPA dated May 5, 2006, CH2M HILL discussed the expectation that the dissolved constituents in groundwater in these monitoring wells will reflect concentrations of the dissolving NAPL (e.g., concentrations as predicted by Raoult's Law) rather than samples being representative of dissolved-phase concentrations in the formation. This request was supported by observations of NAPL globules in groundwater samples collected earlier. However, groundwater samples were collected from these monitoring wells during the first two quarterly sampling events in accordance with the RI/FS Work Plan. NAPL samples were collected and analyzed for chemical constituents and physical characteristics from monitoring, as described in the following section.

NAPL and dissolved-phase concentration information collected from the monitoring wells with NAPL provides sufficient characterization at those locations, and additional analyses of groundwater from these wells would not have provided any additional useful information. The data collected from these wells during the first two rounds should provide sufficient information to evaluate the potential risks associated with the presence of constituents at these locations.

### **2.3.4 Temporary Well Point Installation and Sampling**

During the Jono's Restaurant Building Vapor Intrusion Evaluation, six groundwater grab samples were collected from the top of the water table at six locations on Block 93 North. At five of the six locations (TWP-SB-28, -29, -30, -31, and -32), groundwater grab samples were collected for the analysis of total and dissolved arsenic for the characterization of cinder/ash and reddish-purple soils evaluation.

Temporary groundwater wells were installed by driving a 3.25-inch-diameter steel casing using a direct-push drill rig to a specified depth no deeper than 5.5 feet below the water table (9.5 feet bgs). A 1-foot-long, 1-inch-diameter schedule 40 PVC prepacked well screen was placed in the bottom of the borehole with 1-inch-diameter threaded PVC riser extending above the ground surface. The casing was removed, and formation soils were allowed to collapse around the prepacked screen and riser. Originally, 1-foot screens associated with the temporary monitoring wells were to be installed at shallower depths such that the screens were just below the water table (5 to 6 feet bgs). This was attempted at location TWP-SB-33; however, the length of the well screen, the limited hydraulic conductivity of the saturated soils, and the inability to create a significant hydraulic head variance between the shallow well and the adjacent formation resulted in very low recharge rates. As a result, purging and sampling at this location took approximately 10 hours. Thus, the remainder of the temporary well points was installed to slightly greater depths but no deeper than approximately 5.5 feet below the water table.

Following installation, each temporary well was sampled using a peristaltic pump and disposable polyethylene tubing in accordance with EPA (1998a) protocol. Field parameters (pH, temperature, conductivity, dissolved oxygen, oxidation-reduction potential, and turbidity) were measured using a flow-through cell coupled with a YSI 556 Multiprobe System and a LaMotte® 2020 turbidity meter.

Following stabilization of the field parameters, a field-filtered groundwater sample (preserved with nitric acid) and non-field-filtered (nonpreserved) groundwater sample were collected at each location prior to the flow-through cell. Groundwater samples were

immediately placed on ice and sent to Accutest Laboratory via laboratory courier under executed chain-of-custody forms. Field-filtered and non-field-filtered samples were analyzed for arsenic via EPA Method SW6020.

Screened intervals for each temporary well are summarized in Table 2-3. Samples collected are provided in part of Table 2-4, and groundwater field parameters are listed in Table 2-5.

### **2.3.5 Hydraulic Conductivity Testing**

In situ hydraulic conductivity testing was performed at monitoring wells MW-102A, MW-102B, MW-103, MW-103A, MW-103DS, MW-107, MW-107A, MW-107DS, MW-113A, MW-113B, MW-113C, MW-116A, MW-116B, and MW-116DS. Both rising and falling head tests were performed using a weighted slug, which consisted of a solid PVC cylinder. Prior to initiating the test, a static water level was measured and recorded, and a pressure transducer was placed near the bottom of the monitoring well. The pressure transducer was programmed to record water-level measurements to a data logger at a logarithmic frequency beginning with measurements every second. The weighted slug was then inserted into the well, and the displacement and subsequent fall in hydraulic head were recorded (falling head test). Once the water level returned to static conditions, the data logger was reset, the slug was removed, and the resulting increase in hydraulic head was recorded (rising head test). The data collected, reduced, and interpreted for these tests are discussed in Section 3.3.5. Detailed graphs and interpretations of these tests are presented in Appendix G.

To more fully characterize the physical properties of the confining layer, SJB performed hydraulic conductivity testing by ASTM Method D5084. During the RI, four undisturbed samples were collected in Shelby tubes for testing. The samples were collected from the aquitard interval while advancing the soil borings at SB-101DS, SB-103DS, SB-114B, and SB-121B. The undisturbed samples were collected from 32 to 34 feet bgs at SB-101DS, 22 to 24 feet bgs at SB-103DS, 27 to 29 feet bgs at SB-114B, and 24 to 26 feet bgs at SB-121B. The results of the testing are discussed in Section 3.3.

### **2.3.6 Potential Preferential Pathway Assessment**

In accordance with the RI/FS Work Plan, a potential preferential pathway assessment was performed as part of the RI/FS activities to evaluate the nature and extent of subsurface features at the Site including active or inactive utilities, process lines, and conduits. The goal of this assessment was to determine if these subsurface features and their associated bedding material are, or at one time were, a conduit for constituents to travel from OU1 to either OU2 or neighboring properties.

The assessment began with a field survey in fall 2005 in which observations were made of aboveground evidence of subsurface utilities at the Quanta property (such as manhole covers, exposed pipes, and fire hydrants). A boat was used to observe the area below the concrete pier along the bulkhead at the eastern extent of the Quanta property along the Hudson River. Hand digging was conducted to confirm the location of one subsurface pipeline. Approximate locations of potential subsurface utilities were determined prior to the field survey by researching historical maps of the Site.

In response to comments from EPA on the Draft PSCR, additional research was conducted into buried utilities. Figures were obtained from the Town of Edgewater Engineer and owners of properties adjacent to the Quanta property regarding the presence of subsurface utilities (specifically, storm and sewer drains) at and in the vicinity of the Site. In addition, GeoSyntec summarized the historical utility investigations performed by GeoSyntec Consultants as provided in the RSI (GeoSyntec, 2000b). GeoSyntec work included geophysical surveying, as well as test trenching. Figure 2-4 depicts the locations of the subsurface utilities identified from review of the figures provided by the Town of Edgewater, adjacent property owners, and GeoSyntec.

The final part of the preferential pathways assessment was performed as part of the SI and involved collecting soil samples from the area around or within four pipelines – P1, P2, P3, and P4 (Figure 2-4). These pipelines were observed during the field survey conducted in fall 2005 to extend from OU1 to OU2. P1, P2, and P3 are on the Quanta property; P4 is on the 115 River Road property. P1 was identified as a 36-inch-diameter pipe; P2 was identified as a water line; P3 was identified as a small-diameter pipe; and P4 was identified as a small-diameter stormwater discharge pipe. Soil samples from within or surrounding the pipes were collected with disposable scoops, and the soil was placed in a disposable pan and homogenized before being placed into laboratory jars. Samples were shipped to Accutest Laboratory in Dayton, New Jersey (NJDEP certification number 12129), under executed chain-of-custody forms; there the samples were analyzed for VOCs by EPA Method 8260, SVOCs by EPA Method 8270, and PCBs by EPA Method 8082. During this assessment, all NAPL or NAPL-impacted soils discovered during sampling activities were collected for PAH fingerprinting analysis by META Environmental, Inc., of Watertown, Massachusetts (META). These sample results are presented in Appendix H. Lab reports are provided in Appendix D.

The findings of the potential preferential pathways assessment and the results of the samples collected are discussed in Section 4.5. All known subsurface features that could act as a conduit for the transport of NAPL or other Site-related constituents have been overlaid on a Site plan and included as Figure 2-4.

### **2.3.7 Tidal Study**

A tidal study was conducted at monitoring wells MW-101DS, MW-103A, MW-103DS, MW-107A, MW-107DS, MW-109A, MW-111A, MW-111B, MW-112A, MW-116A, MW-116DS, MW-117A, MW-117B, MW-119A, and MW-120A. Tidal study monitoring was also performed at location TGS-1, where a staff gauge was used to monitor changes in the water level of the Hudson River. At each of these locations, In-Situ® MiniTroll Pro® continuous water level digital recorders were installed and set to record consistently with all digital recorders used. Data were downloaded using the In-Situ, Inc. (Fort Collins, Colorado), software in accordance with manufacturer's specifications.

TGS-1 was installed near the southeastern corner of the pier on the 115 River Road property. The housing to protect the MiniTroll Pro® system (combined pressure transducer and temperature recorder) at TGS-1 was constructed of 2-inch-ID Schedule 40 PVC pipe with a 0.020-inch slotted PVC screen at the base to allow water to reach the MiniTroll Pro®. The screen was installed in the water to allow the probe to extend below the maximum low-tide or low-water mark. The sensor array and transducer intake were at least 1 foot below the



anticipated maximum low-tide or low-water mark to ensure that the components would remain submersed in water during the entire logging period.

Manual depth-to-water measurements were collected from the tidal study monitoring wells and TGS-1 prior and subsequent to deploying the data loggers to obtain a baseline and validate the pressure transducer data. After depth-to-water measurements were recorded, a measuring tape was used to mark the deployment depth on each transducer cable at each of the tidal study monitoring wells and TGS-1. The MiniTroll Pro® subsequently was deployed, secured, and checked to ensure that it was operating as programmed (i.e., the depth reading from the MiniTroll Pro® corresponded to the measured amount of water above the transducer intake). From November 23 to November 28, 2005, the MiniTroll Pro® instruments recorded continuous water-level measurements for each of the tidal study monitoring wells and tidal gauging station TGS-1.

An In-Situ, Inc., BaroTroll® (barometric recorder) was affixed to a tree approximately 10 feet west of MW-104R to measure the barometric pressure and air temperature for the duration of the tidal study. The BaroTroll® was programmed to record measurements at the same intervals as the MiniTroll Pro® instruments. A housing to protect the BaroTroll® was constructed of 2-inch-ID Schedule 40 PVC pipe with a 0.020-inch slotted PVC screen at the base to allow ambient air to interact with the BaroTroll®.

Each of the data recorders was set to record data every 15 minutes. Digital data were downloaded from the continuous recorders, and the data were plotted on hydrographs and conductivity–time series graphics. Data collected during the tidal study are discussed in Section 3.4.2.

### **2.3.8 Synoptic Water Level and NAPL Measurements**

Synoptic groundwater elevation and NAPL thickness measurements were collected at the Site during each quarterly groundwater sampling event and prior to the SI groundwater sampling event. In addition, depth-to-water measurements were recorded prior to development of a monitoring well and sampling.

Each survey was conducted by measuring water levels with an electronic oil–water interface probe or an electronic indicator for the water level. In general, depth to water and NAPL measurements were taken from the top of the inner PVC well riser or inner casing.

Measurements of NAPL thickness were estimated using one of two methods. The first method involves slowly lowering the oil–water interface probe into the monitoring well until the probe indicates the presence of NAPL or the bottom of the monitoring well is encountered. If the probe indicated the presence of NAPL, the initial depth at which the probe indicated a change from water to NAPL was measured from the top of the inner casing. The initial interface depth at which the NAPL was encountered was recorded and subtracted from the total depth of the well to obtain the thickness of the NAPL.

The second method was performed by observing the NAPL coating present on the oil–water interface probe or bailer. Because of the viscosity of the NAPL at some locations and its immiscibility with water, NAPL smearing the outside of the bailers made obtaining accurate NAPL measurements using a bailer difficult. Therefore, the preferred method of observing

NAPL thickness in the monitoring wells was measuring the total length of the NAPL coating the interface probe and measuring tape.

LNAPL was observed in two monitoring wells during the August 14, 2006, synoptic depth-to-water measurement event. Well MW-119A was observed to have approximately 0.5 foot of LNAPL, and Well MW-105 was observed to have approximately 0.01 foot of LNAPL. A summary of historical NAPL observations for monitoring wells at the Site is provided in Table 2-4.

### **2.3.9 NAPL Sampling**

NAPL samples were collected from below the water table from five monitoring wells (MW-102A, MW-105, MW-116B, MW-107, and MW-112B) to augment those NAPL samples that Parsons had previously collected. These five monitoring wells were selected on the basis of the differing physical characteristics (e.g., viscosity and color) of the NAPL observed in each of these wells.

One LNAPL sample was collected from above the water table in the one monitoring well located on the former Lever Brother's property (MW-7) in which a measurable thickness of LNAPL was observed.

NAPL samples were collected using dedicated, weighted Teflon® bailers. The samples were transported via overnight courier to META under executed chain-of-custody forms for the analysis of the following parameters (summarized in Table 2-6):

- Qualitative hydrocarbon fingerprints and total hydrocarbons by EPA Method 8100 modified
- Aliphatic fractions for petroleum hydrocarbon biomarker compounds by EPA SW-846 Method 8270 modified
- VOCs by EPA SW-846 Method 8260 modified
- SVOCs and extended PAH profiles by EPA SW-846 Method 8270 modified
- PCBs by EPA Method 8082 modified (after sample cleanup by EPA Methods 3665 and 3660)
- Metals by EPA SW-846 Method 6010B (except for mercury, which was analyzed by EPA SW-846 Method 7471A)
- Physical properties: viscosity by ASTM Methods D-445 and D-2161, interfacial tension by ASTM Method D-971, American Petroleum Institute (API) gravity by ASTM Method D-4052, density by ASTM Method D-4052, and specific gravity by ASTM D-4052

Prior to chemical analyses, all samples were prepared by waste dilutions (EPA 3580) using dichloromethane. The analytical findings are discussed in Section 4. Appendix D provides the reports that META prepared for results of all NAPL samples collected at the Site (including those that Parsons collected), and Appendix I includes data tables of these results.

### 2.3.10 TarGOST® Investigation

A dynamic “real-time” NAPL delineation program using TarGOST® coupled with direct-push drilling techniques was utilized during the SI activities to further define the distribution of coal-tar NAPL and to determine if its presence is contiguous among points where it has been observed to date. TarGOST® is a down-hole, laser-induced, fluorescence-screening tool developed and operated by Dakota Technologies of Fargo, North Dakota. According to the manufacturer, TarGOST® was “developed exclusively for detection of coal tars, creosotes, heavy crudes, and tank bottoms” (Dakota Technologies, 2008). Specifically designed for use with direct-push drilling techniques, TarGOST® detects NAPL in the subsurface, responding almost exclusively to coal tars and creosote by sensing the fluorescence of PAHs found in these types of NAPL. It is not used to distinguish between different types of coal tar. Residual and mobile coal tar NAPL from the same source are indistinguishable by TarGOST®.

TarGOST® collects subsurface data by emitting rapid pulses of green laser light through the probe and measuring the resultant fluorescence response of the soils in an adjacent window as it is deployed into the subsurface. Return data are converted into digital values that are presented as color-coded, scaled graphical logs in real time. The amount of NAPL present relative to other depths and locations is determined through the regular calibration of the system to a known fluorescence-emitting reference (RE) material prior to each sounding. The resulting down-hole data are plotted as a function of depth and viewed in relation to the RE (as the percent of the reference emitter).

The “TarGOST® User’s Guide” (Appendix J) states that “asphalt-like [tar-like materials] which are solid/plastic fluoresce very poorly.” According to the guide, TarGOST® is designed to respond only to the NAPL-impacted soils, not the PAHs attached in “dry” form to soot or to dissolved phase PAHs. The guide also states that rotting wood and vegetation can sometimes be mistaken for coal tar waste; it is possible that peat emits a waveform that interferes with that emitted by coal tar. Prior to the commencement of the SI activities, a small volume of each of the NAPL samples collected during initial RI activities was sent to Dakota Technologies, where its fluorescence response was confirmed using TarGOST® and Ultra-Violet Optical Screening Tool™ (UVOST™) to confirm the suitability of TarGOST® for detecting Site-specific NAPL. UVOST™ detects typical bulk petroleum, fuels, and light oils. Results of this evaluation indicated that TarGOST® would be the most effective tool for detecting the types of NAPL that have been observed at the Site and that are believed to be related to former operations at the Site. Results of the TarGOST® evaluation on Site-specific NAPL are included as Appendix J.

During the SI activities, 93 TarGOST® borings were advanced from September 25 to October 18, 2006, to depths of approximately 37 feet bgs. SGS operated the Geoprobe™ 6010 direct-push rig that was used to advance the TarGOST® probe. The TarGOST® borings were advanced to the depth specified in the RI/FS Work Plan Addendum (CH2M HILL, 2006d). In general, the TarGOST® borings were advanced deep enough to delineate the vertical extent of coal-tar NAPL. As such, the TarGOST® borings were advanced until the TarGOST® equipment indicated that the fluorescence response of the material “at depth” was similar to the background fluorescence response of the material at that location (usually less than 15 percent RE) or until the confining unit or refusal was encountered. For locations where the TarGOST® response was near background fluorescence response throughout the

depth of the boring (i.e., a minimally affected boring), the drilling was terminated once the confining unit was encountered. This contact was evidenced by the ease of direct-push drilling (no hammer blows) and/or by using subsurface geological data from previous investigations to extrapolate the approximate depth of the top of the confining unit.

Proposed TarGOST® locations for each property were based on the understanding of the distribution of NAPL and the need to confirm the following:

- Extent of NAPL at adjacent properties, specifically at the former Lever Brothers property to the south and the former Celotex property to the north, where coal-tar delineation work was previously performed by other consultants.
- Distribution of NAPL at those locations where it already had been identified required further refinement to determine its vertical distribution and whether it is contiguous among those points where it had been identified to date.
- Whether “product staining” or “black product” observed in soils west of River Road during the RI activities in fall 2005 indicated the potential for the presence of NAPL west of River Road in Block 93 (Lots 1, 2, and 3). If so, the extent of Site-related NAPL in this area would require delineation.

A grid pattern was used to determine the locations where TarGOST® borings would be advanced (shown in Figure 2-5). TarGOST® borings were generally no greater than 100 feet from each other, except near the limits of the coal-tar delineation line that had been established based on data from previous subsurface investigations including the PSCR (CH2M HILL, 2006b) and Environ (2006a, b). In this area the TarGOST® boring spacing and grid densities were reduced from 100 to 50 feet because the focus of NAPL delineation in this area was to confirm and/or refine the findings presented in the letter from Environ. TarGOST® boring spacing and grid densities also were reduced to 50 feet west of River Road, where the planned investigation was limited by the presence of River Road and other surface features. TarGOST® boring spacing along the easternmost grid axis within the Quanta property also was reduced to 50 feet due to the well-documented presence of NAPL in this area and the need for greater resolution in the immediate vicinity of where NAPL could potentially discharge to the Hudson River. A total of 66 locations were planned for TarGOST® screening.

TarGOST® borings were completed on a property-by-property basis, beginning with locations where NAPL had been identified previously and working outward. To ensure that the peripheral extents of coal tar were established, select TarGOST® borings at each property were designated as dynamic profile locations (DPLs). DPLs were generally the outermost proposed TarGOST® boring locations. Once all the TarGOST® borings for a given property had been profiled using TarGOST®, the DPLs where coal tar was detected were delineated by stepping out a maximum of 100 feet in four directions along the established grid axes and drilling additional TarGOST® borings. The threshold RE percentage that was used to determine whether to step out from a DPL and continue delineation evolved over the course of the fieldwork. Initially, 15 percent RE was used, but that number was refined and moved higher, to approximately 35–40 percent RE, and visual and other evidence (e.g., staining on downhole tools, staining in boreholes, obvious coal tar/creosote/naphthalene odors) also were considered when determining whether to

further delineate using TarGOST®. Stepping out at DPLs resulted in the installation of 27 additional TarGOST® boring locations. All completed TarGOST® locations are depicted on Figure 2-5. TarGOST® logs are included in Appendix J. The results of the TarGOST® investigation are discussed in Section 4.1.1.

Soil samples were collected for analytical testing at 22 TarGOST® locations. Soil samples were collected using a Geoprobe® direct-push Macro-Core® sampler with the procedure described in Section 2.2.1. In general, confirmatory soil sampling locations were selected to allow for the collection of additional analytical soil data in areas where the extent of coal tar-related constituents below the applicable soil-screening criteria had not been established or where TarGOST® responses deemed aberrant on the basis of the results of previous subsurface investigations were detected. Confirmatory borings were advanced to the top of the confining unit or to the top of bedrock in areas where the confining unit is not present. Figure 2-5 depicts the locations of the confirmatory soil samples. The confirmatory soil samples and parameters for which they were analyzed are included in Table 2-2. Boring logs for confirmatory soil borings are included in Appendix B.

### 2.3.11 Vapor Intrusion Evaluations

As EPA and NJDEP requested, vapor intrusion evaluations were performed at three properties adjacent to the Quanta property: the 115 River Road buildings, Building 9 on the former Lever Brothers property, and the Jono's Restaurant building on the Block 93 North property. The purpose of these evaluations was to identify potential indoor air exposure pathways to building occupants from soil and groundwater impacts resulting from the past operations associated with the Site.

A complete description of the vapor intrusion data evaluations (including data collected as part of investigations performed on adjacent properties) and the results of these evaluations are presented in technical memoranda that have been previously submitted to EPA (Appendix K). The vapor intrusion evaluations are briefly described below and are also discussed in Section 4.6.

#### 115 River Road Building Complex

Work at the 115 River Road property was conducted based on a three-tier sampling rationale, where the first phase quickly identifies if a potential pathway exists at the Site, the second compares measured or estimated concentrations of constituents in various media to risk-based screening values, and the third conducts a more detailed evaluation of the vapor intrusion pathway, typically to involve direct measurement of vapor intrusion potential.

Three distinct buildings occupy the 115 River Road property. The principal structure consists of two attached buildings (the main building and the newer pier building). A third, smaller, two-story brick building (Building 12) is north of the main building. Both the pier building and Building 12 have inhabited office spaces over parking lots. The main building is divided into 10 different tenant-occupied "buildings," numbered from east to west as Buildings 2 through 11. Much of the main building is leased as office space. Other buildings are used for commercial graphic production, medical offices, a day care center, consumer products marketing, and a modeling agency. Basements are located under Buildings 8 and 10; the Building 8 basement extends under Building 7, which houses a day care center. The

Building 10 and Building 7/8 basements are unoccupied and are used as storage space. Building 6 has a half basement that is leased as office space.

**2006 Vapor Intrusion Evaluation.** A Site-Specific Assessment was conducted in accordance with the “Draft Guidance for Evaluating the Vapor Intrusion to Indoor Air Pathway from Groundwater and Soils” issued by EPA Office of Solid Waste and Emergency Response (OSWER) (EPA, 2002a). In addition, the final “Vapor Intrusion Guidance,” issued in October 2005 by NJDEP, was used as a reference.

Indoor air, outdoor air, and subslab samples were collected during two sampling events at the 115 River Road buildings: a winter season event performed March 18–19, 2006, and a summer season event performed July 29–30, 2006. The sampling locations were identified during a building walkthrough survey conducted February 27–28, 2006, attended by representatives from EPA. The sampling events were conducted according to a work plan (CH2M HILL, 2006e) approved by EPA on March 20, 2006. The results from these two sampling events are summarized in technical memoranda (CH2M HILL, 2006g,h), presented in Appendix K, and are discussed further in Section 4.6.1.

QA/QC samples were collected in the frequency and the manner specified in the revised QAPP (CH2M HILL, 2006a). The analyses were performed by Columbia Analytical Services (CAS), in Simi Valley, California, using EPA Method TO-15. CAS is certified for TO-15 analyses by NJDEP (Certification Number CA009).

**Indoor Air Samples.** Twenty indoor air samples were collected at the 115 River Road buildings during the March 2006 event. These sampling locations were resampled during the July 2006 event to account for seasonal variation, and one additional sample location was added in the basement of Building 8. Indoor air samples from occupied spaces were collected from a height between 2 and 5 feet above the ground (roughly, height of the breathing zone). Samples were collected in 6-liter Summa canisters equipped with flow controllers adjusted by the laboratory to collect an air sample over a 24-hour period. A pressure gauge was used to measure the pressure in the Summa canister before and after sampling.

**Outdoor Air Samples.** Eight outdoor air samples were collected during each of the March and July sampling events. The sampling locations were the same for both events. Two samples were collected on the main building roof and one was collected outside of the building. Three samples were collected at the Quanta property along the fence line. Two samples were collected approximately 1 mile north at locations along River Road. Samples were collected over 24 hours in 6-L Summa canisters in the same manner as indoor air samples. A pressure gauge was used to measure the pressure in the Summa canister before and after sampling.

**Subslab Samples.** Eight subslab sampling probes were installed at the 115 River Road building during the March 2006 event. Three probes were installed in the Building 12 parking garage, two in the Building 10 basement, and three in the Building 8 basement. Subslab sample probes were installed flush with the building floor using an industrial hand drill and concrete masonry drill bits. The probe hole was sealed at the floor surface with mortar and leak-checked using helium to ensure that ambient air was not introduced along with the subslab vapor sample. The probe was purged for 10 minutes with a vacuum pump

to prime it for sampling. During the vacuuming process for the March event, five of the eight probes flooded (water was drawn into the probe). As a result, subslab samples could not be collected at these locations. During the July event, attempts were made to collect samples from the same eight subslab probes. Four of the five probes that flooded in the March event flooded again in the July event. One of the probes sampled in March was damaged and could not be resampled in July.

***Building Surveys.*** The field sampling team noted apparent activities in the sampling areas (such as chemical use or storage) that potentially could have influenced the indoor air sampling results during the March and July 2006 sampling events.

A complete building survey was conducted in September 2006. During this survey, a more detailed inventory of products stored and used within the buildings was created to identify the storage and use of chemicals within the buildings that could emit VOCs which could be interferences in indoor air samples.

***Building Pressurization Survey.*** In April 2007, a pressurization survey was conducted to create a pressure map using a digital micromanometer. The purpose of this survey was to identify indoor spaces with significant depressurization, which could provide a driving force for the completion of the vapor intrusion pathway. Air current tubes were used along with visual observations to detect penetrations through walls or floors, which could represent conduits for subsurface vapor to migrate to indoor spaces.

**2008 Supplemental Vapor Intrusion Evaluation.** Indoor air, outdoor air, and subslab samples were collected between March 22 and 26, 2008, at the 115 River Road building under atypical operating conditions. Based on the result of the March 2008 sampling, several indoor air locations were resampled on April 26 and 27, 2008, under normal operating conditions, to obtain a more realistic representation of site conditions. The results from these two sampling events are summarized in a technical memorandum (CH2M HILL, 2008c) presented in Appendix K and discussed further in Section 4.6.1.

Sampling was conducted according to the EPA-approved “Vapor Intrusion Evaluation at 115 River Road Work Plan Addendum” (CH2M HILL, 2008e) and the EPA-approved “Vapor Intrusion Evaluation Work Plan” (CH2M HILL, 2006a). Several modifications to the March 2008 work approach were made based on a Site visit with the agencies on March 20, 2008. Specifically, the Building 8 basement vent fans were turned off and sealed with plastic; samples were analyzed for the full TO-15 list; and one indoor air sample location in the Building 6 half basement was added.

QA/QC samples were collected at the frequency and in the manner specified in the revised QAPP (CH2M HILL, 2006a). The analyses were performed by CAS using EPA Method TO-15.

***Indoor Air Samples.*** Fifteen indoor air samples were collected at the 115 River Road buildings during the March 2008 event, 10 of which had been sampled previously in 2006. The sampling locations were reviewed and approved by NJDEP and EPA during a site visit on March 20, 2008. In occupied spaces, the Summa canisters were placed on top of a bookshelf or table between 2 and 5 feet above ground surface (roughly breathing zone height), with the exception of Q1-IA-26 and Q1-IA-28, which were placed on the floor. In the basements of Buildings 8 and 10, the Summa canisters were placed on the floor, with the

exception of Q1-IA-21, which was placed on a table approximately 3 feet above ground surface. The ventilation fans in the Building 7/8 basement were turned off and sealed with plastic during the sampling event in accordance with the agencies' request during the March 20, 2008, site visit.

Indoor air resampling was performed April 26 and 27, 2008, at four locations under normal building ventilation conditions: the two locations in the Building 7/8 basement (Q1-IA-21 and Q1-IA-23), which had exceeded the NJDEP Rapid Action Levels (RALs) and Health Department Notification Levels (HDNLs) for benzene in the March 2008 sampling event, and two locations in the Building 7 daycare (Q1-IA-12 and Q1-IA-26).

Samples were collected in 6-L Summa canisters that were equipped with flow controllers and adjusted by the laboratory to collect an air sample over a 24-hour period. A pressure gauge was used to measure the pressure in the canisters before and after sampling.

**Outdoor Air Samples.** Outdoor (background) air samples were collected from six of the eight previous outdoor locations in March 2008: two on the roof of the main building, one in the parking lot, two at the Quanta property along the fence line, and one approximately 1 mile north on River Road. One outdoor air sample was collected in April 2008 on the roof of the main building. Samples were collected over 24 hours in 6-L Summa canisters in the same manner as the indoor air samples. A pressure gauge was used to measure the pressure in the Summa canister before and after sampling.

**Subslab Samples.** Subslab soil gas sampling was attempted in March 2008 at the seven existing subslab probes: three in the Building 7/8 basement, two in the Building 10 basement, and two in the Building 12 parking lot. Two of the subslab probes were reinstalled: Q1-VI-07, in the Building 12 parking lot, whose probe cap was stuck and could not be sampled during the July 2006 sampling event, and Q1-VI-02, in the Building 10 basement which had failed the helium leak check after it was installed in March 2006. Subslab samples were successfully collected from four of the seven probes: two in the Building 12 parking lot (Q1-VI-07 and Q1-VI-08); one in the Building 7/8 basement (Q1-VI-06), and one in the Building 10 basement (Q1-VI-02). Probes were leak-checked using helium to ensure that ambient air was not introduced along with the subslab soil gas sample. Each probe was purged for 10 minutes with a vacuum pump to prime it for sampling. Samples were collected over a 5-minute period in 1-L Summa canisters. A pressure gauge was used to measure the pressure in the canisters before and after sampling. Water was encountered during either purging or sampling at the other three remaining probes and so samples were not collected at these locations.

## **163 Old River Road**

The Tomaso's Ristorante building (the former Jono's Restaurant) is at 163 Old River Road on Block 93 North, across River Road from the Quanta property.

**2007 Shallow Groundwater Sampling.** Subsurface conditions on the Block 93 North property prohibit soil gas sampling because the shallow groundwater table is at 3.5–4 feet bgs, and sampling likely would result in soil gas samples containing groundwater or interference from ambient air due to short-circuiting. Therefore, groundwater samples were collected and evaluated in an effort to help determine the completion of the soil vapor intrusion



pathway based on observed concentrations and attenuation factors in a manner consistent with EPA guidance.

A groundwater grab sample was collected from the top of the water table at each of six locations to the north, west, and south of the building on June 4 and 5, 2007. Enviroscan, Inc., conducted a subsurface utility survey prior to the groundwater grab sampling event. Samples were collected from temporary well points installed using a direct-push drill rig. The temporary wells were constructed from 1-inch PVC with 1-foot-long prepacked well screens, as described in Section 2.3.3. The temporary wells were purged and sampled with a peristaltic pump using low-flow sampling techniques in accordance with EPA guidelines (EPA, 1998a).

Groundwater samples collected were analyzed for VOCs by EPA Method 8260 and SVOCs by EPA Method 8270. QA/QC samples were collected in the frequency and the manner specified in the revised QAPP (CH2M HILL, 2006a). Details regarding the required containers, preservatives, and holding times for groundwater samples are provided in the Field Sampling Plan for the RI/FS Work Plan (Parsons, 2005). Samples were transported by overnight courier to Accutest Laboratories under standard chain-of-custody protocol.

**2008 Supplemental Vapor Intrusion Evaluation.** Indoor air, outdoor air, and subslab soil gas samples were collected at the building between March 23 and 25, 2008, to further evaluate the potential vapor intrusion pathway. Sampling was conducted according to the EPA-approved “Vapor Intrusion Evaluation at 163 Old River Road Work Plan Addendum” (CH2M HILL, 2008d) and the EPA-approved “Vapor Intrusion Evaluation Work Plan” (CH2M HILL, 2006e). On the basis of the site visit with the agencies on March 20, 2008, the work approach was modified to include analysis of the samples for the full TO-15 analyte list. The results from this sampling event is summarized in the technical memorandum (CH2M HILL, 2008d) presented in Appendix K, and discussed further in Section 4.6.3.

QA/QC samples were collected at the frequency and in the manner specified in the revised QAPP (CH2M HILL, 2006a). The analyses were performed by CAS using EPA Method TO-15. CAS is certified for TO-15 analyses by the NJDEP (Certification Number CA009).

Indoor air samples were collected from three locations, which were reviewed and approved by NJDEP and EPA during the site visit on March 20, 2008. The Summa canisters were placed on top of a table approximately 4 feet above the ground (roughly breathing zone height). One outdoor air sample was collected at the south side of the building at a height of approximately 3 feet. Two subslab soil gas probes were installed in the kitchen and storage room. The subslab sample probes were installed flush with the building floor using an industrial hand drill and a concrete masonry drill bit. The probe hole was sealed at the floor surface with Portland cement and leak-checked using helium to ensure that ambient air was not introduced into subslab soil gas sample. The probe was purged for 10 minutes with a vacuum pump to prime it for sampling.

Indoor and outdoor air samples were collected in 6-L Summa canisters that were equipped with flow controllers and adjusted by the laboratory to collect an air sample over a 24-hour period. Subslab soil gas samples were collected over a 5-minute period in 1-L Summa canisters. A pressure gauge was used to measure the pressure in the canisters before and after sampling.

### 2.3.12 Seasonal Standing Water Sampling

To be able to evaluate potential ecological risks associated with the presence of large areas of seasonal standing water at the Site, EPA requested the collection of a sample from each of four locations where it is common for standing water to accumulate during wetter times of the year. Locations of these samples (SW-A, SW-B, SW-C, and SW-D) are depicted in Figure 2-3. Water quality parameters were measured at these four locations with a Horiba U-22 water quality meter. These field parameters are presented in Table 2-5. The samples were analyzed for those constituents indicated in Table 2-4. The results of this sampling are discussed in Section 7.

### 2.3.13 NAPL Recovery Testing

Accumulated NAPL was pumped from monitoring wells in December 2006 and July 2007, and subsequent measurements were used to test the removal and subsequent rebound of accumulated NAPL in select monitoring wells. The objectives of this work were as follows:

- To recover NAPL from the Site
- To collect additional data on the recoverability and mobility of NAPL at the select monitoring wells
- To evaluate the behavior of measurable NAPL in the monitoring wells over time

CH2M HILL submitted the results of the testing to EPA in the “Non-Aqueous Phase Liquid (NAPL) Recovery Testing Results—Quanta Resources Superfund Site” technical memorandum on November 6, 2007.

#### December 2006 NAPL Recovery Test

On December 13, 2006, the first NAPL pumping event was conducted. Clean Harbors, Inc. of Edison, New Jersey (Clean Harbors) operated a vacuum truck with CH2M HILL oversight.

Prior to applying the vacuum to monitoring wells MW-102A, MW-112B, MW-116B, MW-104R, MW-105, MW-103, and MW-102, the depth-to-water and NAPL thickness were measured. Depth-to-water measurements were made using a Heron® Dipper T water level meter. NAPL thickness was measured by lowering a small weight attached to a string through the NAPL interval and measuring the stained length of the string or, for measuring the more viscous NAPL in MW-105, pushing a 0.75-inch-diameter PVC pipe through the NAPL interval, and measuring the NAPL-stained length.

A 3,500-gallon-capacity Cusco® vacuum truck was used to extract NAPL from the select monitoring wells. One of two methods was used to extract NAPL from the monitoring wells: either a 1-inch-diameter steel drop-pipe was used to extend from the vacuum tube to the NAPL–water interface in the monitoring well (or as close as practicably possible) or the vacuum tube was lowered directly to the bottom of the well. The vacuum was applied for 5 minutes or until NAPL and groundwater were no longer being recovered, whichever occurred first. If the monitoring well dewatered, the well was allowed to recover until the depth to water was close to the prevacuum depth. Once the water level recovered, the well was vacuumed again.

NAPL thickness was gauged prior to attempting to extract NAPL, again at least 2 hours after NAPL recovery activities had ceased, and twice more, at 1 week and 1 month following the pumping event. Measurements were made by field staff to determine the volume of NAPL pumped from each well (versus groundwater). Following the completion of vacuum-extraction activities at each monitoring well, the contents of the vacuum truck were emptied into 55-gallon drums. After allowing time for the NAPL to settle in the drums, a measuring device was lowered into the drum to determine the percentage of each drum that contained only NAPL. This percentage was used to determine the volume of NAPL in each drum rather than groundwater. A total of 109 gallons of NAPL was recovered during the December 2006 event.

CH2M HILL submitted a memorandum summarizing the observations and measurements for the December 2006 NAPL recovery event to EPA on March 8, 2007 (CH2M HILL, 2007m).

### **July 2007 NAPL Recovery Test**

On the basis of the observations and recommendations reported in the memorandum for the December 2006 event, a peristaltic pump was used during the July 2007 event instead of a vacuum truck. On July 10, 2007, the second NAPL extraction event was conducted; 0.5-inch-OD polyethylene tubing was lowered to a depth that corresponded approximately to the bottom of each well. Prior to deployment of the peristaltic pump intake, the NAPL thickness was measured at each well (MW-102, MW-102A, MW-102B, MW-103, MW-105, MW-112A, MW-112B, MW-116A, MW-116B, MW-117A, and MW-118B). NAPL measurements were collected as described for the December 2006 event.

At ground surface, the tubing was connected to the peristaltic pump, and the extraction was initiated by starting the pump and maximizing the flow rate. The purged fluid was discharged into 5-gallon buckets. If the viscosity of the NAPL caused pumping difficulties, tubing was purged by rapidly and repeatedly raising and lowering the tube to aid the pumping process. At monitoring well MW-112B, a weighted Teflon® bailer also was used due to the higher viscosity of the NAPL, which clogged the polyethylene tubing. The bailer was lowered to the bottom of the well and raised from the well, and the contents of the bailer were emptied into 5-gallon buckets. The NAPL was transferred from those 5-gallon buckets into 55-gallon drums and stored onsite for subsequent disposal. To determine the volume of NAPL pumped from each well relative to the amount of groundwater removed, the contents of the 5-gallon buckets were measured following the completion of the NAPL extraction activities at each monitoring well by lowering a measuring device to the bottom of the bucket to gauge how much of the volume was NAPL versus groundwater (i.e., a dipstick method). A total of 39 gallons of NAPL was recovered during the July 2007 event.

Approximately 2 hours following the completion of the NAPL removal activities the NAPL thickness at each location was gauged to evaluate recovery. Additional measurements were also taken at each location 1 week and 1 month following the NAPL removal.

CH2M HILL submitted a memorandum to EPA summarizing the July 2007 NAPL Recovery Test on November 6, 2007 (CH2M HILL, 2007l).

### 2.3.14 Arsenic Dust Evaluation

Surface soil samples were collected from the Quanta property for analysis and subsequent evaluation of the potential air pathway based on the procedures in the EPA “Rapid Assessment of Exposure to Particulate Emissions from Surface Contamination” (Cowherd et al., 1985). Surface soil samples were collected from depths of 0–6 inches at 12 locations. Nine sampling locations were on the Site proper, while two locations were on Block 93 Central and one location was on Block 93 North. The samples were collected using disposable plastic spoons and homogenized in disposable metal pans. Large particles were sifted out (e.g., roots and stones greater than 1 cm or 0.5 inch in diameter) and the samples were transferred into labeled, clean, laboratory-supplied glassware.

Overhead photographs were made of each sampling location. These photographs documented the presence and extent of stones larger than 1 cm in diameter in the soil.<sup>7</sup> As described below, these overhead photographs were compared with photographs presented in Appendix A of the EPA guidance document (Cowherd et al., 1985) to quantify the fraction of nonerrodible elements in the surface soil. Angled photographs were taken of the area around each sample location to estimate the fraction of vegetative cover present.

Grain-size analysis using both sieve and hydrometer testing (ASTM Method D422) was performed on each soil sample. These data grain sizes were used to estimate the mode size of particles at each location sampled, as described in the guidance document (Cowherd et al., 1985). In addition, arsenic concentrations were determined in each soil sample using EPA SW-846 Method 6010.

The results of the arsenic dust evaluation are presented in their entirety in the “Additional Evaluation of Potential Air Exposure Pathways at the Quanta Resources Site, Edgewater, New Jersey” (CH2M HILL, 2007h), included in Appendix K of this RI Report.

## 2.4 Field Equipment Decontamination

Decontamination was performed to remove potential contaminants, prevent transfer of harmful materials, and prevent cross-contamination during the course of field activities. When using HSA drilling, the drill rigs were steam cleaned before and after use at each monitoring well or boring location at a decontamination pad near the center of the Site. A pump was used to transfer the decontamination water that collected in the decontamination pad into 55-gallon drums. When using direct-push drilling, all down-hole tools were scrubbed with Alconox® and potable water, and then rinsed with potable water. Wash water that was generated during decontamination of the direct-push drilling equipment was emptied daily into 55-gallon drums.

Decontamination of nondedicated and nondisposable sampling equipment was conducted in buckets on plastic sheeting. Sampling equipment (e.g., Grundfos® and QED pumps and water quality probes) were decontaminated thoroughly each day before use (“daily decon”) and after each well was sampled (“between-well decon”), as specified by NJDEP (2005). Sampling equipment was wrapped in aluminum foil for storage or transportation from the designated decontamination area to the sample locations.

---

<sup>7</sup> Stones larger than 1 cm in diameter are defined as “non-errodible elements” in EPA guidance (Cowherd et al., 1985).

## 2.5 Management of Investigation-Derived Waste

IDW generated from RI field activities was managed and disposed of in accordance with applicable federal, state, and local regulations. Types of IDW generated included soil, groundwater, sediment, NAPL, and disposable sampling equipment. CH2M HILL containerized solid and liquid IDW generated during the RI field activities. Clean Harbors, under contract with Honeywell, performed the hazardous waste characterization and removed the waste in drums from the Site.

IDW was contained in Department of Transportation (DOT)–approved 55-gallon, open-top steel drums. The exception was sampling equipment that was not contaminated with NAPL, which was contained in plastic bags and disposed of as solid waste. Upon placement of material within a drum, the drum was labeled with the type of media it contained, location of origin of the media, and date of waste generation. The labeling of waste containers prior to offsite transportation was performed in accordance with 49 CFR 172, 173, and 178. Drums were staged at one of two areas on the Quanta property, either a fenced area near the gate opening onto River Road or an area on the east end of the property, to maintain security and aesthetics prior to offsite disposal.

Clean Harbors determined the hazardous waste characteristics of the generated IDW as required by NJAC 7:26G-6.2 and 40 CFR 261. Waste characterization information was documented on waste profile forms prepared by Clean Harbors. In accordance with 40 CFR 265, hazardous wastes were removed from the property within 90 days of generation. Each load of waste material had a manifest prepared prior to leaving the property. Hazardous wastes were sent to the appropriate RCRA Subtitle C treatment, storage, or disposal facility. Nonhazardous wastes were disposed of at a Subtitle D facility or a municipal landfill, as appropriate.

## 2.6 Database Management, Data Validation, and Data Evaluation

Throughout the investigations, the project analytical database was carefully managed and validated. Laboratory data QA/QC procedures are detailed in Appendix L. First, historical data were obtained and evaluated for usability. Two criteria were used for judging usability, in consideration of laboratory reports, laboratory quality control data and use in previous reports.

All analytical data collected to date were validated following the process outlined in the QAPP. The review of the analytical data was performed in accordance with the EPA “Contract Laboratory National Functional Guidelines for Organic Data Review” (EPA, 1999b), the “EPA Contract Laboratory National Functional Guidelines for Inorganic Data Review” (EPA, 2002a), and EPA SW846 methodology. Quality control criteria were evaluated for all samples as appropriate for each analytical method, such as laboratory blanks, field blanks, field duplicates, laboratory duplicates, matrix spikes and matrix spike duplicates (MS/MSDs), holding times, and sample preservation. The full list of validation criteria is detailed in Appendix L. An overall evaluation of the data indicates that the sample

handling, shipment, and analytical procedures have been adequately completed, and that the analytical results should be considered accurate.

Appendix L also outlines specific procedures followed in the areas of data collection and tracking, laboratory analysis, data loading, electronic data deliverable (EDD) verification, data verification and validation, and data visualization and analysis.

## Site Characteristics

---

This section presents the Site characteristics, including surface features of the properties that make up the Site, the locations of potential preferential pathways, and descriptions of Site-specific geology and hydrogeology, land use, and ecology.

### 3.1 Surface Features

Topography and surface features of properties for which all or part of the property is a component of OU1 are described in the following subsections. These properties include Quanta, former Celotex, 115 River Road, former Lever Brothers, Block 93 North (Lots 1, 2, and 3), Block 93 Central, and Block 93 South. Figure 1-2 depicts these properties and others in the vicinity of OU1.

#### 3.1.1 Quanta Property

The Quanta property is vacant. Exposed tank and building foundations are visible at several locations. The property includes the remains of a former oil-water separator, a wooden bulkhead along the edge of the Hudson River, and the remains of wooden docks. A chain-link fence is maintained around the portion of OU1 east of River Road, except for the boundary with the Hudson River. Warning signs are posted at locations around the Quanta property. The property is inspected monthly to verify the integrity of these land-use controls and to make any necessary repairs. Oil-absorbent booms are maintained at OU2 to contain observed sheens on surface water. The booms are inspected periodically, and oil-saturated booms are removed and put into containers for offsite disposal.

Topography at the property is generally flat and at a lower elevation than the surrounding properties and River Road, resulting in standing water over a portion of the property during most of the year. Some vegetative growth is present where water tends to pond during wet-season periods. A small wooded area is located in the central portion of the property near monitoring well MW-103. The majority of the northwestern portion of the property is devoid of vegetation and covered with gravel or asphalt. The remainder of the property is covered with sporadic wetland vegetation, isolated trees or shrubs, remnant concrete pads, and gravel.

The only substantial vertical relief on the Quanta property consists of a concrete embankment along the west and northwestern property boundaries, forming the transition to higher elevations on River Road and the former Celotex property. Farther to the east, a sheer boulder wall approximately 12 feet high is present along the boundary between Quanta and the former Celotex property to the north.

Two means of access/egress exist on the Quanta property; both are gated with locks. An access driveway from River Road onto the property is near the southwestern corner of the property. This access road consists of cobbles. An asphaltic access driveway is on the northern side of the property near the eastern terminus of the concrete embankment. An

unpaved roadway runs primarily along the southern half of the property from River Road to the wooden bulkhead marking the boundary between OU1 and OU2.

### **3.1.2 Former Celotex Property**

The Quanta property is bordered on the north by the Promenade at City Place development on the former Celotex property. The Promenade at City Place complex includes residential and commercial space and a 122-room hotel. A large parking garage at ground level is constructed below the retail and residential buildings. An area north of the eastern portion of the Quanta property consists of a partially paved and unpaved sloping temporary parking lot. Farther north of the temporary parking area is an unfinished multilevel parking garage, surrounded by a fenced construction zone. The remaining portions of the property consist of landscaping and paved roadways.

### **3.1.3 115 River Road Property**

Bordering the Quanta property to the south is the 115 River Road property (former Spencer-Kellogg property). The majority of this property is improved with a large multitenant building and a smaller parking/office building. The main 115 River Road building consists of two attached buildings that, together, extend approximately 800 feet from end to end and are between 30 and 60 feet wide. The western portion of this building located between River Road and the Hudson River is approximately 500 feet long and dates back to the turn of the twentieth century (referred to in Figure 1-4 as the “Main 115 River Road building”). The main building is approximately 30 to 40 feet high.

The main building is divided into 10 different tenant-occupied “buildings,” numbered from east to west as Buildings 2 through 11 (shown in Figure 1-4). This building is constructed of brick and contains two distinct basements. Basements are located under Building 10 and Building 8; the basement under Building 8 appears to extend partly under Building 7.

The second office building consists of an approximately 300-foot-long expansion of the main building and extends over the Hudson River on a pier. The extension appears to have been constructed in the 1990s (based on the dates of available design drawings) and is referred to in Figure 1-4 as the “pier building.” The pier building has aluminum frame construction with insulated glass and corrugated metal siding and is elevated approximately 10 to 15 feet above the Hudson River. The inhabited office spaces are elevated approximately 12 feet over an open-air parking lot.

A smaller two-story brick building (Building 12), approximately 100 feet by 25 feet and approximately 30 feet high, is north of the main 115 River Road building. The office spaces in Building 12 are elevated over a semi-enclosed parking lot. The remainder of the upland area of the property consists of parking areas paved with either asphalt or concrete.

Little to no natural vegetation or standing water occurs on this property. The topography is flat. A chain-link fence marks the northern and southern property boundary lines.

### **3.1.4 Former Lever Brothers Property**

South of the 115 River Road property is the former Lever Brothers property. This property currently is owned by i.Park Enterprises, LLC, and is in the early stages of redevelopment. Several large, vacant buildings and structures are on the former Lever Brothers property



associated with its historical operations, as well as several paved driveways and parking lots. A large grassy area occupies much of the central and northeastern portions of the property. A large parking lot exists on the northeastern portion of the property. The topography is very flat. The central portion of the property currently is undergoing redevelopment to be a future site for a Borough of Edgewater municipal building. Fences mark the northern, southern, and western boundaries of the property. The property is bordered to the east by the Hudson River.

### **3.1.5 Block 93 North Property**

Three lots on Block 93 (Lots 1, 3, and the northern portion of Lot 2) are located between Old River Road and River Road, and are part of the former Barrett Manufacturing Company property. For purposes of this RI, these lots combined are referred to as Block 93 North. This property is mainly a sloped grassy area with concrete AST pads and an L-shaped concrete wall. Some vegetation and trees exist along the northern portion of the property. Lot 2 is a former railroad right-of-way that is partially paved, with some grass and gravelly areas. A solid waste dumpster, old vehicles, portions of a chain-link fence, and remnants of railroad track are present at Lot 2. A restaurant on Lot 1 was vacant for a period of time and has now been refurbished. An occupancy permit application has been submitted for the restaurant. Lot 1 recently was paved with asphalt. Topography is generally flat with minimal standing water.

### **3.1.6 Block 93 Central Property**

The central portion of Block 93 includes Lots 1.01, 3.03, 3.04, and the southern portion of Lot 2. These lots are adjacent to the former Barrett property, but the lots were never occupied by operations associated with oil recycling or coal-tar processing, according to aerial photographs and historical insurance maps. Lot 1.01 is occupied by a large, vacant building to the south of the former Jono's Restaurant. A sign labels the building as "Faesy & Besthoff Corporation." The former Faesy & Besthoff building is adjacent to Old River Road and occupies the majority of Lot 1.01. The remainder of Lot 1.01 consists of a loading dock for the former Faesy & Besthoff building, a small paved parking area, and a driveway providing access and egress to Old River Road. The southern portion of Lot 2 consists of an unpaved driveway and a linear swath of thick wetland vegetation trending north-south. Lot 3.03 is triangular and consists almost entirely of a wedge-shaped, small, vacant building. Lot 3.04 consists of a demolished building foundation with remnant building structures and concrete rubble in and around the foundation. The topography is flat except where lot 3.04 abuts River Road. Standing water has been observed on Lot 2 in the low-lying areas of the unpaved dirt driveway after rain events.

### **3.1.7 Block 93 South Property**

The southern portion of Block 93 consists of Lots 1.02 and 4. Lot 1.02 is occupied by a Borough of Edgewater pump station. Lot 4 consists of a multitenant medical office building and a paved parking area. A small vegetated area and remnants of railroad tracks are present on the northeastern portion of Lot 4. A chain-link fence separates the central and southern portions of Block 93 along the northern boundary of Lot 4. The topography is flat, and no standing water has been observed on Block 93 South.

## 3.2 Geology

The Site is located in the Piedmont physiographical province of New Jersey. This region, also called the Triassic Lowlands, is marked by the Watchung Mountains: low, north-south-trending hills (Drake et al., 1996). Elevations in this province range from near sea level at the Site to 771 feet farther west. The Triassic Lowlands are underlain by rocks of the late Triassic Newark Supergroup, which is made up of both sedimentary and igneous rocks. According to the Bedrock Geology Map of Northern New Jersey (Drake et al., 1996), bedrock at the Site is composed of a fluvial/alluvial deposit of arkosic sandstone (*feldspathic arenite*), silty mudstone, argillaceous siltstone, shale, and conglomerate known as the Stockton Formation. The Stockton Formation is part of the Newark Supergroup and consists of a narrow area of rock between the Palisades Diabase to the west and Hudson River Deposits to the east (Drake et al., 1996).

According to the “Surficial Geology [Map] of the Weehawken and Central Park Quadrangles, Bergen, Hudson, and Passaic Counties, New Jersey” (Stanford, 1993), the surficial geology of the Site consists of “artificial fill” and “estuarine and salt-marsh deposits.” The artificial fill is described as “artificially emplaced sand, gravel, silt, clay, and rock, and man-made materials including cinders, ash, construction materials, and trash.” The estuarine and salt-marsh deposits are described as “organic silt and clay, salt-marsh peat . . . black, dark brown, and gray on tidal flats . . . brown to gray silt, sand, and minor gravel in tidal channels.” This designation of the surficial geology correlates well to the observed surficial geology for the western portion of the Site; however, the “estuarine and salt-marsh deposits” are overlain by a thin layer of native sand in the eastern portions of the Site (east of Boring SB-6).

As part of the “Brownfield and Contaminated Site Remediation Act” (NJSA 58:10B-1 et seq.) the NJDEP Land Use Management Division and the New Jersey Geologic Survey were required to map large areas of historical fill and make this information available to the public. The 2004 Historic Fill Map of the Central Park Quadrangle (HFM-43) shows that the Site and all the surrounding properties fall within a large area of mapped Historic Fill, defined as that which covers 5 or more acres (NJDEP, 2004). This map is provided as Figure 1-5.

The bedrock Stockton Formation is overlain by 30 to 60 feet of unconsolidated deposits. These deposits consist of 20 to 40 feet of alluvial and estuarine and salt-marsh deposits overlain by 10 to 20 feet of non-native fill. The native estuarine and salt-marsh deposits overlying bedrock at OU1 consist of 5 to 20 feet of fine to medium-grained, well-sorted sand, and/or laminated clayey sand/sandy clay (deep sand unit observed at well MW-107DS), followed by 10 to 25 feet of soft silt and clay that contains traces of roots at shallower depths and shell fragments (confining unit), overlain by 5 to 10 feet of medium to coarse, poorly sorted sand (unconfined unit). Discontinuous peat and sand layers of varying thicknesses are observed above the confining unit in the western portion of OU1 (east and west of River Road). Non-native fill overlies the native soils throughout OU1. This material consists of a mixture of gravel, sand, and silt with cinder/slag material, brick, wood, and concrete fragments. In a limited portion of the northwest corner of the Quanta property and the southwest corner of the former Lever Brothers property, unburned or partially burned pyrite ore is present as a component of the fill, giving it a reddish-purple appearance.

At OU1, the following overburden stratigraphy is generally observed (listed in order encountered from ground surface):

- **Fill material:** Up to approximately 22 feet of fill consisting of silt, sand, gravel, rock, building debris such as concrete and brick, wood, cinders, and slag.
- **Shallow sand:** Up to approximately 20 feet of fine to medium/coarse sand with varying amounts of fines.
- **Peat/clayey peat:** Up to approximately 15 feet of organic peat or “meadow mat” with varying amounts of clay, fine sand, and silt – observed in less than half of all RI subsurface sampling locations, predominantly in the western half of OU1. This unit is sometimes found to be underlain by a thin layer of native sand.
- **Silty clay (confining unit):** Up to approximately 25 feet of generally continuous silty clay with varying amounts of fine sand. This unit pinches out against the bedrock high to the north of the Site (former Celotex property).
- **Deep sand:** Up to approximately 25 feet of fine to coarse sand, sand with varying amounts of silt and clay, and silt and clay with varying amounts of sand (classified as part of the “deep sand” unit if observed below a cleaner sand and the silty clay confining unit – i.e., MW-107DS). The deep sand unit pinches out against a bedrock high to the north and terminates east of the Site, where it has been scoured by the Hudson River. The distribution of deep sand deposits immediately adjacent to the river is not fully understood at this time. Additional investigation along the shoreline in the vicinity of the wooden bulkhead has been proposed as part of the SRI in order to determine the presence/absence and depth of the deep sand in this portion of the site.

Geologic cross-sections of the Site are provided as Figures 3-1, 3-2, and 3-3. Three-dimensional views of OU1 overburden stratigraphy are provided in Figure 3-4a. Figures 3-4b and 3-4c present contour maps of the top of the silty clay confining unit and the top of bedrock, respectively.

Bedrock is encountered at the Site at 8.5 to 60 feet bgs. Boring B-225 is the deepest boring where bedrock was not observed. Boring B-225 was drilled to 72 feet bgs in River Road without encountering bedrock (PMK, 2000). A bedrock high is present in the south-central portion of the former Celotex property, with bedrock present as shallow as 8.5 feet bgs at SB-T15 and generally no more than 10 to 12 feet bgs (SB-T18, SB-U18, SB-U21, MW-D, and TL 17-03). The shallow overburden unit/upper sand pinches out completely (SB-T15 and SB-T18) where the fill directly overlies bedrock or thins to approximately 2 to 4 feet (MW-D, SB-U18, SB-U21) where the silty clay and deep sand pinch out completely. A historic map shows this bedrock high and an outcrop surrounded by wetlands prior to development of the former Celotex property (Burr, 1832).

Rock has been observed in several borings at or near the depth of refusal, and has been cored in two locations (GeoSyntec, 2001). At Boring B-3 on the Quanta property (near MW-104R) a red sandstone conglomerate was encountered between 36.5 feet bgs and 57 feet bgs. Bedrock in this location was cored from 55 to 60 feet bgs and was observed to be a yellowish-gray sandstone conglomerate from 55 feet bgs to 57 feet bgs and a red/red-brown to yellow-gray siltstone/mudstone from 57 to 60 feet bgs. At Boring B-4, also drilled on the

Quanta property near the MW-102 well cluster, a reddish-brown sandstone conglomerate was encountered at 55 feet bgs and was observed to extend to 68 feet bgs where it transitioned into a reddish-purple, slightly metamorphosed, fractured siltstone/mudstone. The siltstone/mudstone was observed from 68 feet bgs to 72 feet bgs, where the boring was terminated. At Boring B-4 bedrock was cored from 67 to 72 feet bgs (GeoSyntec, 2001). Based on the observations of bedrock at Borings B-3 and B-4, the bedrock at the Site correlates well to the description of the Stockton formation from the Bedrock Geology of Northern New Jersey Map (Drake et al., 1996).

A tidally influenced mud flat/marsh connected to the Hudson River borders OU1 immediately to the east of the wooden bulkhead. These river sediments consist of silt to clayey silt approximately 45 feet thick immediately east of the bulkhead; these sediments thicken eastward to approximately 250 feet in thickness beneath the main channel of the river (Parsons, 2005). These mud flats are exposed approximately 500 feet from shore during low tide and are under approximately 6 feet of surface water during high tide.

### 3.3 Hydrogeology

Three distinct overburden hydrostratigraphic units exist at the Site above the bedrock surface.

- **Shallow, unconfined water table unit:** Consists of up to approximately 25 feet of saturated fill material and shallow sands
- **Silty clay aquitard (confining unit):** Approximately 10 to 25 feet of silt, clay, silty clay, and/or clayey/silty peat
- **Deep sand unit:** 0 to 25 feet of fine to coarse sand, sand with varying amounts of silt and clay, and silt and clay with varying amounts of sand

The hydrostratigraphic units are illustrated in the cross-sections provided in Figures 3-1 through 3-3, and in the three-dimensional (3D) depictions of the OU1 geology in Figure 3-4a.

The shallowest hydrostratigraphic unit consists of an unconfined, surficial water-bearing zone extending from the water table to approximately 15 to 25 feet bgs. The water table is observed in monitoring wells screened across the water table at approximately 3 to 4 feet bgs on each of the properties that compose the Site, except on the former Celotex property. On the former Celotex property, the water table is observed at approximately 10 to 12 feet bgs due to the higher ground elevation. In the area of the bedrock high, the shallow hydrostratigraphic unit is not expected to be present (no monitoring wells are in the area of the most elevated bedrock high, likely due to the water table being below the top of the bedrock) or expected to be very thin. Monitoring well MW-D in this area is screened to the top of bedrock, and saturated deposits observed here are only 0.5 foot thick.

The fill/shallow sand overburden unit is underlain by a silty clay aquitard approximately 10 to 25 feet thick. A confined water-bearing “deep sand” unit exists between the aquitard (confining unit) and the bedrock surface. The deep sand unit is between 0 and 25 feet thick and extends to the bedrock surface located at 8.5 to 60 feet bgs. In some places at OU1, the

potentiometric surface of this water-bearing zone is approximately 1 to 3 feet higher than the overlying unconfined water table unit (i.e., upward vertical hydraulic gradients), suggesting that these two units are not connected hydraulically; the silty clay aquitard provides a hydraulic barrier between the two water-bearing units. The silty clay aquitard has a measured hydraulic conductivity of 0.0001 foot per day at 15 to 17 feet bgs at monitoring well MW-108 (GeoSyntec, 2001). The distribution of deep sand deposits adjacent to the Hudson River in the vicinity of the wooden bulkhead remains an uncertainty that will be addressed as part of the SRI.

To more fully characterize the physical properties of the confining layer, hydraulic conductivity testing by ASTM Method D5084 was performed. The reported hydraulic conductivity values for samples collected from the silty clay interval ranged from  $4.06 \times 10^{-7}$  cm/s to  $8.19 \times 10^{-8}$  cm/s. The low permeability values of these undisturbed samples support the classification of the silty-clay interval as an aquitard. The analytical results of the permeability tests are summarized in Table 3-1.

### 3.3.1 Groundwater Flow Directions

Synoptic water level elevation surveys were conducted during each quarterly groundwater sampling event. During these surveys, depth-to-groundwater measurements were recorded in shallow and deep sand monitoring wells during low- and high-tide conditions. The results of these events are summarized in Tables 3-2 and 3-3. Figures 3-5 and 3-6 illustrate the direction of groundwater flow under mid-tide conditions for both the shallow and deep sand hydrostratigraphic units, respectively, in October 2006 (the most comprehensive round of water level measurements taken during RI activities). Groundwater potentiometric contour maps for both these units during high and low tides for all RI monitoring events between 2005 and 2006 are provided as Appendix M of this report.

It should be noted that historical groundwater flow patterns may not always have been the same as those observed during RI activities, given changes in topography, drainage, and the placement and removal of subsurface utilities and paved surfaces. The nature of historical flow patterns constitutes an uncertainty that cannot be resolved. Aside from the topographic low and lack of paved surfaces at the current Quanta property, the presence of the wooden bulkhead is both a current and historical feature that is, and has likely been for a long time, a major feature controlling Site hydraulics. For these reasons, the quantitative hydraulic head data that have been collected from the Site as part of the RI and used to develop the understanding of current groundwater flow paths as described below also have been used for evaluating the fate and transport of COIs in groundwater at the Site. Additional comprehensive groundwater elevation measurements will be collected as part of the SRI in order to confirm current groundwater flow directions.

#### Shallow Hydrostratigraphic Unit

In the shallow hydrostratigraphic unit, the highest groundwater elevations occur at the northwestern portion of the Quanta property. Shallow groundwater flow direction was mapped using wells screened across the water table. To calculate groundwater flow parameters, an arithmetical average of the hydraulic gradients was calculated from the data collected during each synoptic measurement event for high and low tides. Evaluation of groundwater elevation data indicates that the direction of the shallow groundwater is

predominately to the southeast, under an average hydraulic gradient of 0.0068 foot/foot during low-tide conditions and 0.0066 foot/foot during high-tide conditions.

An area of slight mounding in shallow groundwater is consistently observed near the central portion of the Quanta property. The groundwater mounding is likely a result of increased localized recharge in this area due to its relative low-lying topography and the unpaved ground surface in this area. As a result of this groundwater mounding, localized groundwater flows radially outward from this area. This mounding also could be due in part to the wooden bulkhead (approximately 250 feet downgradient) impeding shallow groundwater discharge to the Hudson River, thus creating a back-up of groundwater in the eastern and central portions of the Quanta property. To attempt to quantify the radial groundwater flow, the average hydraulic gradients at low and high tide over the four quarterly synoptic measurement events to the west, north, and east of the groundwater mounding area were calculated. The average hydraulic gradients at low tide are 0.0007 foot/foot, 0.0014 foot/foot, and 0.0029 foot/foot, to the west, north, and east, respectively. No significant variance was observed between conditions at high and low tide.

Using Darcy's equation, average linear groundwater flow velocities were calculated in the shallow hydrostratigraphic unit using the geometric means of the "A" and "B" wells and an assumed effective porosity of 25 percent. In the shallow hydrostratigraphic unit, the calculated seepage velocity was 0.55 foot/day to the southeast during low tide and 0.54 foot/day during high-tide conditions.

### **Deep Sand Hydrostratigraphic Unit**

As with the shallow hydrostratigraphic unit, the highest groundwater potentiometric surface elevations in the deep sand hydrostratigraphic unit are in the northwest portion of the Quanta property. Groundwater flow direction for the deep sand hydrostratigraphic unit was mapped using only those wells screened within the deep sand unit. Groundwater flow direction in this unit is also predominately to the east/southeast, under a hydraulic gradient of 0.0004 foot/foot during low-tide conditions and 0.0007 foot/foot during high-tide conditions.

Average linear flow velocities were calculated in the deep sand hydrostratigraphic unit using an average hydraulic conductivity of 8 feet/day and an effective porosity assumption of 25 percent. The calculated average linear velocities in the deep sand hydrostratigraphic unit were 0.01 and 0.02 foot/day during low and high tide, respectively.

### **Vertical Hydraulic Gradients**

Vertical hydraulic gradients were calculated between the deep sand unit and the shallow unconfined groundwater zone (across the confining unit). Results of these calculations are summarized in Table 3-4 and are illustrated in cross-sections (shown in Figures 3-1 through 3-3). Vertical hydraulic gradients within the shallow hydrostratigraphic unit to the west of the Site are downward. At greater distances from the Hudson River, the direction of the vertical component of groundwater flow in the shallow groundwater shifts upward. However, the presence of the wooden bulkhead at the foot of the Quanta property creates a hydraulic barrier, forcing hydraulic heads to accumulate in this portion of OU1 and cause downward vertical hydraulic gradients in the shallow hydrostratigraphic unit behind this feature adjacent to OU2. Farther south, along the shoreline where the wooden bulkhead is

absent, vertical hydraulic gradients in well couplets screened in the shallow deposits adjacent to the river shift upward. Several of the wells in this area have vertical hydraulic gradients that are tidally influenced and shift downward during high tide. This effect is not observed in wells adjacent to the bulkhead on the Quanta property.

In the deep sand unit, hydraulic heads are consistently higher than those observed in collocated wells screened at the base of the unconfined shallow groundwater zone. The vertical hydraulic gradients measured in the four wells screened in the confined aquifer remain upward across high- and low-tide conditions. The presence of upward vertical hydraulic gradients across the shallow saturated zone and deep sand units, as well as differing groundwater flow directions in both, confirms that the two hydrostratigraphic units are not connected hydraulically.

### **Groundwater Convergence**

An area of groundwater convergence is observed near the central to eastern portions of the former Lever Brothers property. This convergence is observed on the high tide groundwater elevation contour map (Figure 3-5). A large-diameter (approximately 3 feet) outfall pipe discharges into the Hudson River near the area where the convergence feature typically is observed. The pipe and/or the artificially emplaced material surrounding it, if present, could be influencing groundwater flow in a localized area.

## **3.3.2 Hydraulic Conductivity Testing Results**

Interpretations of the hydraulic conductivity slug tests were made using the Bouwer and Rice (1976) method for both confined and unconfined monitoring wells. This method was based on the initial findings of Bouwer and Rice (1976) and subsequently confirmed by Bouwer (1989) and Brown et al. (1995) as being suitable for confined wells. Detailed graphs and interpretations of these tests are presented in Appendix G, and these data are summarized in Table 3-1.

### **Shallow Groundwater Hydrostratigraphic Unit**

Results of the hydraulic conductivity tests conducted at five monitoring wells screened within the shallow hydrostratigraphic unit indicate that monitoring wells screened across the water table ("A" wells) have a range of hydraulic conductivity values of 3 to 118 feet/day ( $1.1 \times 10^{-3}$  cm/s to  $4.2 \times 10^{-2}$  cm/s), with a geometric mean of 17 feet/day ( $6.0 \times 10^{-3}$  cm/s). The six monitoring wells screened at the base of the shallow hydrostratigraphic unit ("B" wells, MW-113C, and wells without a letter designation) that were tested have a range of values from 1 to 129 feet/day ( $3.53 \times 10^{-4}$  cm/s to  $4.55 \times 10^{-2}$  cm/s), with a geometric mean of 16 feet/day ( $4.29 \times 10^{-3}$  cm/s). These hydraulic conductivity values are consistent with geology observed during the soil boring and monitoring well installation program and indicate a consistency in hydraulic conductivities across varying depths within the shallow hydrostratigraphic unit.

### **Deep Sand Hydrostratigraphic Unit**

Results of the hydraulic conductivity tests conducted at three monitoring wells screened within the deep sand hydrostratigraphic unit ("DS" wells) indicate a range of hydraulic

conductivities for the deep sand between 5 and 27 feet/day ( $1.8 \times 10^{-3}$  cm/s and  $9.5 \times 10^{-3}$  cm/s) with a geometric mean of 8 feet/day ( $2.8 \times 10^{-3}$  cm/s).

### 3.3.3 Tidal Study Results

Hydrographs for the shallow and deep sand unit monitoring wells included in the tidal study are provided in Figures 3-7 and 3-8, respectively. Tidal influences on the shallow and deep sand hydrostratigraphic units decrease westward from the Hudson River. Typically, variance in groundwater elevations in monitoring wells at the northwestern portion of the Quanta property are small compared to those in monitoring wells on the southeastern portion of the property. These differences are illustrated in the potentiometric contour maps for both high and low tides for each quarterly monitoring event (shown in Appendix M). Wells along the shoreline of the Quanta property (MW-116, MW-117, MW-118, and MW-105) do not appear to be nearly as tidally influenced as those along the river to the south at the 115 River Road and former Lever Brothers properties, or those wells to the north at the former Celotex property. This lack of response is a result of the presence of the wooden bulkhead in this area, which appears to be acting as a hydraulic barrier between surface water and shallow groundwater. Review of the potentiometric contours near the bulkhead (Appendix M) reveals that shallow groundwater hydraulic heads are building up behind this barrier. The difference in head measured in surface water versus the head measured in the shallow groundwater wells adjacent to the bulkhead, as well as the lack of tidal response in these monitoring wells, suggests a limited hydraulic connection between groundwater west of the bulkhead and surface water at OU2.

Groundwater flow direction at the Site remains consistent between daily tidal events (low and high tides); however, the hydraulic gradient is slightly steeper during low-tide conditions due to the tidal response in monitoring wells adjacent to the Hudson River (hydraulically downgradient portion of the Site). Monitoring wells in the deep sand hydrostratigraphic unit are influenced more heavily by tidal conditions than monitoring wells in the shallow hydrostratigraphic unit.

## 3.4 Demography and Land Use

### 3.4.1 Demography

The Borough of Edgewater, New Jersey, is approximately 3 miles long and 0.75 mile wide (at its widest point). The U.S. Census 2005 population estimate for Edgewater is 9,646 residents (U.S. Census, 2005). This reflects an estimated 26 percent population increase from the U.S. Census 2000 levels (U.S. Census, 2000).

Edgewater's population distribution by ethnicity (U.S. Census, 2000) is as follows: white, 67 percent; Asian, 23 percent; and Hispanic and other racial and ethnic groups, 10 percent.

According to U.S. Census Bureau 2000 data, approximately 15 percent of the residents are persons under 18, and approximately 9 percent are senior citizens aged 65 and older. About 87 percent of the working residents in Edgewater are employed in service, managerial, sales, and office occupations. Approximately 13 percent are employed in construction, production, maintenance, and transportation occupations.



### 3.4.2 Land Use

According to the Borough of Edgewater zoning map, revised January 30, 2003, the Quanta property is classified as OR-1 (Office and Research District). Land use designations for neighboring properties of interest are as follows:

Property Name	Block/Lot	Zoning
Former Celotex	Block 91, Lot 1	MCRD (Mixed-Use Commercial/Residential Development District)
115 River Road	Block 96, Lots 3.01 and 4.01	OR-1 (Office and Research District)
Former Lever Brothers	Block 99, Lots 1 and 5	OR-1 (Office and Research District)
Block 93 North	Block 93, Lots 1, 2 (north portion), 3, and 3.04	OR-1 (Office and Research District)
Block 93 Central	Block 93, Lots 2 (south portion) and 1.01	OR-1 (Office and Research District)
Block 93 South	Block 93, Lot 4	OR-1 (Office and Research District)

## 3.5 Cultural Resources

A Stage IA Literature Search and Sensitivity Analysis (also known as a Stage IA Cultural Resources Survey) of OU1 was conducted in accordance with the January 2007 Work Plan (approved by EPA on February 26, 2007). The following paragraphs describing the conclusions of the survey duplicate the material presented in the “Stage IA Cultural Resources Survey Report” submitted to EPA on May 30, 2007 (JMA, 2007):

No properties currently listed on the State or National Registers of Historic Places are present within [the Quanta property] or the greater Project Area [i.e., OU1] where remediation activities are proposed. A single property previously determined to be eligible for the National Register—the Spencer Kellogg and Sons, Inc. Pier and Transit Shed—is located within the Project Area, on the southern edge of [the Quanta property]. The Spencer Kellogg and Sons, Inc. pier and transit shed were determined eligible under criteria A and C in 1984. In the intervening 23 years, the pier and transit shed were razed and rebuilt as a two-story parking garage. The resource now lacks integrity and thus, in the opinion of JMA, is no longer considered an eligible property. South of [the Quanta property] the Spencer Kellogg and Sons, Inc. production and pressing plant was determined to be ineligible for the NRHP in 1984. The files of the New Jersey HPO and the NJSM were consulted and no previously recorded archeological sites are known to exist in or near the Project Area.

Analysis of historic cartography indicates the presence of four previously unknown historic architectural properties within the Project Area. The onsite reconnaissance indicated that these four buildings are intact and do retain historic fabric. These buildings are present within tax parcel block 93, across New River Road, to the west of [the Quanta property]. It is our understanding that there are no current remediation plans for this parcel. This parcel was included in the Project Area at the client’s request, for the purpose of future planning purposes. JMA recommends that an intensive level architectural survey may be necessary on tax parcel 93 after the locations and methods for future remediation activities in this area have been determined.

There is no potential for the presence of intact prehistoric archeological remains within [the Quanta property]. Further, it is highly unlikely that construction and operation of proposed remediation in the Project Area will impact significant prehistoric archeological deposits. Based on the findings of the historic archeological sensitivity analysis, there is no potential for the presence of significant historic archeological resources in [the Quanta property]. JMA recommends that no further archeological investigations are necessary or warranted within [the Quanta property].

Within the Project Area, historic sensitivity analysis demonstrates that a small area of block 93 contained buildings in the early twentieth century. Disturbance to this area is limited to filling. Further, the lack of structures prior to the twentieth century and the ancillary utilitarian nature of the known buildings on block 93 diminishes the likelihood of significant historic archeology deposits. Therefore, JMA recommended that no archaeology investigation is necessary in the Project Area.

In summary, proposed remediation activities confined within [the Quanta property] will not adversely affect any significant archeological or historical resources. However similar remediation, if carried out on tax parcel 93, may affect potentially significant historic architectural resources. If proposed remediation activities could result in a visual impact or change to the setting of a potential historic structure within the Project Area, then JMA recommends that an intensive-level architectural survey be conducted to determine if any historically or architecturally significant structures or properties are present on tax parcel 93 that could be affected by the proposed remediation activities.

## 3.6 Ecology

Ecological characteristics of OU1 were evaluated as part of the SLERA for OU1. This section summarizes a portion of the final SLERA, which is further discussed in Section 7.

### 3.6.1 Habitat

The limited urban habitat of the Quanta property is characterized as having low ecological resource value with no sensitive habitats. Approximately 30 percent of the Quanta property is covered with pavement and asphalt. A road with small parking areas crosses the property from west to east. The remainder of the property consists of barren areas (approximately 20 percent of the property) covered with debris or old foundations and some areas covered by vegetation. The only viable habitat on the property consists of an urban old field community of plants with shrubs and small trees that covers approximately 50 percent of the property and runs along both sides of the access road. The western end of the property is open near the property entrance but is increasingly vegetated eastward, toward the river. The vegetation in this area is characterized by pioneer weed species typical of disturbed areas, including common ragweed (*Ambrosia artemisifolia*), burdock (*Arctium minus*), bull thistle (*Cirsium vulgare*), daisy fleabane (*Erigeron annuus*), smartweed (*Polygonum* sp.), and goldenrod species (*Solidago* sp.). Several thick stands of common reed (*Phragmites australis*) are clustered in wet areas on OU1. A larger patch of common reed is located along the southern side of the property. Several small trees and shrubs are growing in patches in the old field community. The most common tree on the property is quaking aspen (*Populus tremuloides*). Larger trees are located on the borders of the property. The eastern side of the property is more heavily vegetated; however, because of its small size and industrialized/disturbed nature, the property generally provides poor-quality habitat.

No permanent aquatic habitats are on the upland portion of OU1. Large puddles were noted on the western and northern sides of OU1 in October 2005, following a period of heavy rain. These puddles were not present in spring and summer 2005.

### 3.6.2 Biota

The relatively small size and historically industrial nature of the Quanta property has resulted in conditions that do not support a diverse or extensive ecological community. The vegetated area of the property could provide cover and food for herbivorous and soil-invertebrate-eating small mammals. However, no signs of small mammals were observed at OU1 during the summer and fall of 2005, and the soils at OU1 appeared to be of poor quality. The nature of the soils and fill material found at OU1 do not appear to support a healthy plant and soil invertebrate community and, therefore, might not support small mammals. If small mammals were present, they would provide food for higher-trophic-level predators. Small mammals that could potentially use the OU1 habitat include the short-tailed shrew (*Blarina brevicauda*), meadow vole (*Microtus pennsylvanicus*), white-footed mouse (*Peromyscus leucopus*), Norway rat (*Rattus norvegicus*), and raccoon (*Procyon lotor*). Raccoon tracks were observed on OU1. Birds observed on the property or likely to use this habitat include American robin (*Turdus migratorius*), song sparrow (*Melospiza melodia*), mourning dove (*Zenaidura macroura*), white-throated sparrow (*Zonotrichia albicollis*), house sparrow (*Passer domesticus*), red-winged blackbird (*Agelaius phoeniceus*), starling (*Sturnus vulgaris*), and possibly urban avian predators such as red-tailed hawks (*Buteo jamaicensis*). During a site visit in October 2005, Canada geese (*Branta canadensis*) were noted nesting at OU1.

### 3.6.3 Threatened and Endangered Species

The occurrence of threatened and endangered species within a one mile radius of OU1 was evaluated by contacting the U.S. Fish and Wildlife Service (USFWS), National Oceanic and Atmospheric Administration (NOAA) National Marine Fisheries Service, and the NJDEP Natural Heritage Program. Information was requested for both terrestrial and aquatic species although the Ecological Risk Assessment is addressing only terrestrial receptors.

Information provided by the USFWS indicated that no federally listed or proposed endangered or threatened flora or fauna are known to occur within a 1-mile radius of the Site. The New Jersey Natural Heritage Database and the Landscape Project do not indicate the occurrence of any rare wildlife or plant species or ecological communities within a 1-mile radius of OU1.

The NOAA response indicated that endangered fish species could be present in the adjacent Hudson River and that the area is designated as Essential Fish Habitat (EFH). Aquatic receptors will be addressed as part of the OU2 investigation.

## SECTION 4

# Nature and Extent of Contamination

---

This section discusses the nature and extent of contamination at the Quanta Resources Superfund Site, with the Site defined as the Quanta property and any areas where contamination from the property has come to be located. The extent of contamination defining OU1 is described in the following subsections.

Section 4.1 discusses suspected and known sources of contamination, both from Site-related historical manufacturing operations and adjacent property operations. Each of these sources is described in detail, including the specific constituents related to the source, chemical and physical characteristics of the constituents, and a description of delineation and field sampling methods. Section 4.2 describes the COIs, which were developed for soil and groundwater by screening analytical results against various soil and groundwater criteria. The final list of COCs has been developed as part of the Human Health Risk Assessment (HHRA) and is discussed in Section 7.0 and attached as Appendix P. The SLERA is discussed in Section 7.0 and provided in Appendix Q. Sections 4.3 and 4.4 discuss results from soil and groundwater sampling, respectively, as part of investigations for this RI report. Section 4.5 discusses the results of preferential pathways sampling, and Section 4.6 discusses the results of vapor intrusion investigations. Section 4.7 summarizes the lateral extent of impacts in soil and groundwater, including NAPL impacts, and the resultant delineation of OU1.

## 4.1 Sources of Contamination

Historical operations included coal-tar processing operations and, subsequently, oil recycling operations. As a result of historical Site activities, secondary sources of NAPL, hard pitch, and soil containing VOCs, SVOCs, and metals remain at the Site today.

Prior to 1985, when initial removal actions were proposed, the property had 61 ASTs, an unknown number of USTs, and underground piping. The total storage capacity of the tanks was over 9 million gallons. The tanks were used to store “oil, tar, asphalt, sludge, process water, and other unknown liquids.”

A former acid plant, located on the northern portion of the Quanta property and the southern portion of the former Celotex property, contributed to the presence of oxidized pyritic ore remnants in soil.

As a result of the well-documented history of heavy industrial activities near the study area (Environ, 2005, 2006a; PMK, 2000; Appendix A), additional sources of groundwater and/or soil contamination not related to former onsite operations are present within the lateral extent of OU1. These sources include the following.

- Historical filling throughout this portion of Edgewater, New Jersey (NJDEP, 2004)
- Identified AOCs at the former Lever Brothers property (Langan, 2003-2004)

- Upgradient source of chlorinated solvents impacting groundwater within the confined deep sand unit
- PCBs in soil at adjacent properties (Enviro-Sciences, Inc., 1997; EWMA, 2000; GeoSyntec, 2000a)

Based on these potential source areas, supplemental investigations and evaluations were conducted to evaluate the impact of historical activities on the Quanta and surrounding properties and to elucidate links between former operations and specific impacts found throughout the Site and surrounding area. The results of these evaluations are included in the following subsections.

#### **4.1.1 Non-Aqueous Phase Liquid**

A detailed understanding of the extent of NAPL across the Site has been developed using multiple lines of evidence, including visual evidence in soil borings and monitoring wells, laboratory analytical data, and the measured fluorescence response of soils using the TarGOST® tool.

Visual evidence of both free-phase and residual NAPL has been observed in soil borings throughout the Quanta and 115 River Road properties, as well as southern portions of the former Celotex property, eastern portions of Block 93 North and Central, and the northern portion of the former Lever Brothers property (Table 4-1). In addition, measurable thicknesses of NAPL have been observed in monitoring wells screened above the confining unit at the Quanta and 115 River Road properties and the northern portion of the former Lever Brothers property. At two locations, MW-105A and MW-119A (shown in Figure 2-3), LNAPL was observed during the August 2006 synoptic depth-to-groundwater measurement event. Locations where NAPL has been observed in soil borings and monitoring wells are marked in Figure 4-1. A summary of NAPL thickness measurements and groundwater elevation data collected during RI activities is provided in Table 4-1.

NAPL that has been observed in groundwater-monitoring wells at the Site is typically slightly denser than water and accumulates at the base of certain monitoring wells. NAPL observations at the Site are summarized in Table 4-1. LNAPL was observed during the August 2006 synoptic water-level event floating on the top of the water column in two monitoring wells: MW-105A and MW-119A at thicknesses of 0.1 and 0.5 foot, respectively. GZA staff also observed LNAPL at monitoring well MW-7 in the northern portion of the former Lever Brothers property during environmental investigations being performed at that property in 2006 (GZA, 2006a, b). A subsequent measurement performed by CH2M HILL on May 15, 2006, identified an accumulation of 5 feet of LNAPL on top of the water column in monitoring well MW-7.

Between November 2003 and May 2006, samples of NAPL were collected from select monitoring wells (MW-102, MW-102A, MW-103, MW-104, MW-105, MW-112B, MW-116B, and MW-107), and a sample of LNAPL was collected from MW-7. In addition, samples were collected from two locations in the Hudson River adjacent to the Quanta property (SEEP-1 and SEEP-2). All samples were sent to META for chemical and fingerprinting analyses, a forensic chemistry laboratory specialized in the analysis of coal tar for environmental investigations. NAPL and LNAPL samples collected during RI activities between 2005 and 2006 (MW-102A, MW-105, MW-112B, MW-116B, MW-107, and MW-7) were analyzed at

META for select physical parameters (viscosity, interfacial tension, API gravity at 60°F, density, and specific gravity). Samples of LNAPL observed in monitoring wells MW-119A and MW-105A could not be collected due to the limited thicknesses and/or the emulsification of LNAPL in the water during attempts to collect a sample. A summary of the results of fingerprinting and physical analysis is provided in Table 4-2. Chemical analysis results for samples collected during RI activities are summarized in Appendix I. Laboratory reports generated by META for all NAPL samples collected at the Site are provided in Appendix D. The results of these analyses are presented below.

### **Chemical Composition**

The most common SVOCs detected in NAPL samples from the Site were naphthalene, phenanthrene, 2-methylnaphthalene, and C1-phenanthrenes/anthracenes. Overall, naphthalene is the most common PAH detected in the NAPL samples. The highest concentrations of SVOCs were detected in NAPL from monitoring well MW-107.

Several SVOCs were detected in the LNAPL existing in monitoring well MW-7, including fluoranthene, pyrene, and C1-fluoranthenes/pyrenes. However, naphthalene was not detected, and concentrations of detected PAHs were at least one order of magnitude lower than the NAPL samples. The MW-7 LNAPL sample is considerably different than the NAPL samples in the remaining monitoring wells and could be a result of former operations on former Spencer-Kellogg or former Lever Brothers properties.

VOCs detected in NAPL samples included 1,2,4-trimethylbenzene, 1,3,5-trimethylbenzene, benzene, ethylbenzene, isopropylbenzene, naphthalene, n-propylbenzene, p-isopropyltoluene, styrene, toluene, and xylene. None of these constituents was detected in the LNAPL sample from MW-7.

Antimony, arsenic, chromium, copper, lead, selenium, silver, zinc, and mercury were detected in some or all NAPL samples. The inconsistency of these metals' concentrations among individual NAPL samples suggests that metals detected in NAPL likely are not a function of the composition of the NAPL itself but are a result of interference from groundwater in these samples. The relative distribution of metals concentration in NAPL samples across the Site is consistent with observed concentrations of metals in groundwater (discussed in Section 4.4).

PCBs were not detected in any NAPL sample collected at the Site. A summary of all analytical results for the chemical analyses of NAPL samples collected during the RI are provided in Appendix I. Laboratory reports are provided in Appendix D.

The lower concentrations of SVOCs and the absence of naphthalene, benzene, and other VOCs suggest that the LNAPL measured at MW-7 is fundamentally different than the NAPL samples collected across the Site.

### **Identification of NAPL**

Laboratory data from the NAPL sample collected from MW-7 had different physical and chemical properties from other NAPL samples, where the data indicated it was derived

from a petrogenic<sup>8</sup> source. Specifically, the chemical characterization showed low levels of steranes and terpane biomarkers and sesquiterpanes. No n-alkanes or isoprenoids were detected. The only SVOCs detected were PAHs such as fluoranthenes, pyrene, C1-fluoranthenes, and pyrenes. These results, as well as the GC/FID (gas chromatograph/flame ionization detector) fingerprinting of this sample indicate that the material is an unknown hydrocarbon mixture, not coal tar. The library search performed by META Labs for the results of this sample indicated that the material present is a complex mixture of branched chained alkylbenzenes (BABs). BABs are synthetically produced hydrocarbons used as surfactants (cleaners) in the home-products industry, of which Lever Brothers was part. For example, sulfonated BAB has been used to manufacture detergents.

NAPL detected at MW-7 is likely the result of a separate localized release associated with historical soap-manufacturing operations at the former Lever Brothers property and therefore is not considered Site related.

A review of the results from the chemical analysis of other NAPL samples (as opposed to the NAPL sample collected from MW-7 and described above) collected at the Site since 2003 indicates that all samples are pyrogenic<sup>9</sup> in nature. All NAPL samples collected at the Site are characterized by a lack of alkanes and petroleum biomarker compounds; however, they have a dominance of unsubstituted PAHs, bolstering evidence that the NAPL is pyrogenic in nature. A comparison of the ratios of fluoranthene/pyrene to dibenzofuran/fluorene (a common comparative technique) in each of the samples indicates that each of the NAPL samples was formed under a relatively high-temperature process.

Using the results from each sample location, the degree of weathering exhibited by each NAPL sample was assessed based on its composition and abundance of various constituents. On the basis of this assessment, the NAPL sample collected from monitoring well MW-105 and both samples collected from the Hudson River shoreline area (SEEP-1 and SEEP-2) are considered to be slightly weathered. These samples are characterized by a slight reduction in the relative composition of naphthalene, 2-methylnaphthalene, and 1-methylnaphthalene relative to other NAPL samples collected. NAPL samples collected from monitoring wells MW-102, MW-102A, MW-103, MW-104, MW-107D, MW-112D, and MW-116D are considered to be relatively unweathered because of the dominance of the more easily weathered two-ring PAHs in these samples. Overall, the patterns of detected constituents in the samples are consistent with coal carbonization tars, coke, oven tars, and creosotes. Further, the similarity of PAH histograms provided in the laboratory reports (Appendix D) indicates that the NAPL samples have similar chemical properties.

In general, the constituents detected in the NAPL samples are consistent with dissolved-phase constituents detected in groundwater at the Site. As a multicomponent product, the dissolution NAPL is governed by Raoult's Law (Kent, 1974), which states that the

---

<sup>8</sup> Petrogenic (i.e., petroleum-based) substances include crude oil and crude oil derivatives such as gasoline, heating oil, and asphalt (META, 2006a).

<sup>9</sup> Pyrogenic substances are complex mixtures of primarily hydrocarbons produced from organic matter subjected to high temperatures but with insufficient oxygen for complete combustion. Pyrogenic materials are formed by fires, internal combustion, engines, and furnaces. They are also formed when coke or gas are produced from coal or oil. Coal-tar-based products, such as roofing materials, pavement sealers, waterproofing, pesticides, and some shampoos, contain pyrogenic materials (META, 2006a). Pyrogenic PAHs are typically 3-, 4-, and 5- ring PAHs, such as phenanthrene, anthracene, fluoranthene, pyrene, benz(a)anthracene, chrysene, benzo(b)fluoranthene, benzo(k)fluoranthene, benzo(a)pyrene, indeno(1,2,3-cd)pyrene, and benzo(ghi)perylene.

propensity of a given constituent to dissolve into groundwater is a function of not only its solubility, but also a function of the mole fraction that the constituent represents within the NAPL mixture. The product of these two factors results in the effective solubility of a constituent in a given NAPL. Effective solubility also represents roughly the theoretical maximum concentration that could be found in groundwater that is in equilibrium with the NAPL.

A preliminary comparison was made between the constituents with the highest effective solubility for each NAPL sample and the concentration of those constituents in groundwater samples collected from the same wells to determine if the NAPL was the likely source of groundwater impacts at the Site. With a few exceptions (likely a result of additional complexities surrounding multicomponent NAPL dissolution, as well as the potential presence of small amounts of NAPL in groundwater samples), those constituents observed to have higher effective solubility in the NAPL were typically the constituents most frequently detected in groundwater and at the highest concentrations (i.e., naphthalene, benzene, and phenols).

### Physical Characteristics

LNAPL and NAPL samples collected during RI activities were analyzed for physical parameters to better understand the characteristics that govern the mobility of the observed NAPL and LNAPL.

The kinematic viscosity of the LNAPL/NAPL that was sampled ranged from 3.49 to 181.6 centistokes (cSt) at 122°F. The laboratory was not able to conduct viscosity measurements on samples at lower temperatures due to the high viscosity of the samples. The samples collected from monitoring wells MW-107 and MW-7 exhibited the lowest viscosities at 3.49 cSt and 4.93 cSt, respectively. Samples collected farther north were found to exhibit higher viscosity, such as those from MW-102A at 14.31 cSt. NAPL with increasingly higher viscosities were observed still farther north, in monitoring well MW-112B at 61.23 cSt and along the Hudson River in MW-105 at 181.6 cSt. These data support field observations that NAPL observed at MW-112B and MW-105 was “thick” and difficult to penetrate with the sampling device. NAPL at MW-107 was the easiest to sample, flowing freely into the sample container.

NAPL samples from monitoring wells MW-105 and MW-112B were analyzed for Saybolt Furol Second (SFS) viscosity (Table 4-2). The SFS method of measuring is largely obsolete but is used in the petroleum industry for very high viscosity samples.

The interfacial tension values for the NAPL samples ranged between 8.2 and 30.2 dynes/cm<sup>2</sup>. Interfacial tension represents the force that exists in the interface between two immiscible fluids (in this case, groundwater and NAPL). The lower these forces, the greater propensity the NAPL will have to spread over a greater area. Interfacial tension measured in the NAPL samples is consistent with values typical of NAPL at industrial sites, which usually range between 5 and 35 dynes/cm<sup>2</sup> (Advanced Applied Technology Development Facility, 1997; Cohen and Mercer, 1993). Interfacial tension values were lowest in the NAPL sample collected from monitoring well MW-107 (8.2 dynes/cm<sup>2</sup>) and highest in the NAPL sample collected from MW-105 (30.2 dynes/cm<sup>2</sup>).



Density of NAPL samples from monitoring wells MW-7 and MW-107 was measured at 876.8 and 1,049.8 kilograms per cubic meter ( $\text{kg}/\text{m}^3$ ), respectively. These results indicate that the LNAPL from MW-7 is slightly less dense than water ( $1,000 \text{ kg}/\text{m}^3$  at  $4^\circ\text{C}$ ), while the density of the NAPL from the remaining monitoring wells is slightly denser than water.

The specific gravity of the NAPL sampled from monitoring wells MW-102A, MW-105, MW-112B, MW-107, and MW-116B ranged from 1.0505 to 1.1293. The LNAPL collected at MW-7 was determined to have a specific gravity of 0.8772. NAPL from all the wells except for MW-105 was analyzed for API gravity. The result from these tests showed similar results to the specific gravity analysis (see Table 4-2). Results of the density and specific gravity analyses were consistent with where the LNAPL and DNAPL were observed within the monitoring well water column.

### **Coal-Tar NAPL Delineation (TarGOST®)**

The identification of all NAPL samples as coal tar (with the exception of LNAPL at MW-7) is consistent with historical operations at the former Barrett property. Visual observations and laboratory analytical data collected using conventional investigative methods (drilling, soil screening and sampling, and groundwater sampling) prior to and during this RI suggest that coal tar NAPL is present in the subsurface above the silty-clay aquitard (Figure 3-4b) across significant portions of the Quanta property, 115 River Road property, and near monitoring well MW-107 at the former Lever Brothers property. Although NAPL was not observed in measurable thicknesses in monitoring wells at the former Celotex property, previous coal-tar delineation work performed on the southern portion of the former Celotex property suggested that coal tar impacts are present in this area (Environ, 2006a, b), although the Environ delineation includes staining and odor in addition to free and residual coal-tar NAPL.

To better characterize the lateral extent of free and residual coal-tar NAPL and to gain better resolution of depth and horizontal extent of NAPL between those areas where it previously had been observed, a delineation program using direct-push drilling techniques coupled with a down-hole laser-induced fluorescence screening tool known TarGOST® was implemented. This technology was used as a comprehensive method to identify the location of coal-tar NAPL at the Site. TarGOST® was developed and is operated by Dakota Technologies. The tool is designed specifically for use with direct-push techniques to detect coal tar or creosote NAPL in the subsurface by selectively fluorescing in the presence of PAHs found in these types of products.

As discussed previously, TarGOST® is designed to respond only to the NAPL-impacted soils and does not distinguish between residual and free-phase forms. Dissolved phase PAHs, and the PAHs attached in “dry” form to soot or that are components of solid asphaltlike tars will not be reliably detected by the TarGOST® tool. The presence and distribution of solid tars was determined using a combination of visual observations and laboratory analytical data (Section 4.1.2). It is also important to note that rotting wood and vegetation (like that associated with peat) can sometimes be “detected” as coal tar waste by the TarGOST® instrument.

A grid system, consisting of perpendicular overlapping transects spaced 100 feet apart, was set up over the Quanta property and several adjacent properties. A total of 93 TarGOST®

borings over 15 acres were advanced to collect comprehensive data of the presence and thickness of coal tar. Confirmation soil borings were completed at approximately 10 percent of the TarGOST® locations:

- TL 19-0.5
- TL 17-09
- TL 17-06
- TL 16-07
- TL 14-11.25
- TL 12.5-12.25
- TL 12-10.75
- TL 18.5-1.5
- TL 17-08
- TL 17-05
- TL 16-06
- TL 14-10.75
- TL 12.5-11.75
- TL 11-07.5
- TL 18.5-0.5
- TL 17-07
- TL 16-09
- TL 15-10.75
- TL 14-09
- TL 12-11.75

Confirmatory samples were intended to validate the results of the TarGOST® tool by correlating the TarGOST® response with visual and analytical data. The location of all TarGOST® borings and confirmatory soil sampling locations are illustrated in Figure 2-5, and the results are presented in Table 4-3.

**TarGOST® Field Data.** The TarGOST® signal is the measured fluorescence response of soils adjacent to a window in the probe tip during the advancement of the probe into the subsurface. The response is reported as percent RE (a fluorescence-emitting reference standard developed by the manufacture), which increases in the presence of coal tar. During the advancement of each boring, the TarGOST® tool collects fluorescence response readings at a rate of approximately 1 reading per inch and the signal strength (as percent RE) is plotted with depth. The highest response from the 93 borings across the Site was 933 percent RE at 8.4 feet below grade at boring TL13-05. The lowest maximum response in any single boring was 15 percent RE. TarGOST® boring logs showing the signal response with depth at each TarGOST® boring location are presented in Appendix J.

**Determination of Coal-Tar Response.** Field TarGOST® response data were evaluated in the context of visual field observations, historical analytical data, lithology, and analytical data from confirmatory soil samples. These lines of evidence were used to determine the Site-specific minimum TarGOST® response threshold that indicated the presence of coal tar NAPL. A list of all the TarGOST® locations and nearby soil borings with relevant descriptions of NAPL or coal-tar observations and a summary of the TarGOST® response data plus confirmatory analytical results is provided in Table 4-3. Appendix J presents TarGOST® logs along with photographs of recovered confirmatory samples, soil descriptions, and analytical results. Boring logs for confirmatory soil sampling locations are included in Appendix B.

Based on the evaluation described above, the Site-specific minimum TarGOST® response level indicating the presence of residual or free-phase coal tar NAPL was determined to be 49.1 percent RE. This level is within the range of minimum response levels expected by Dakota Technologies based on their experience at similar sites (St. Germain, 2006).

With few exceptions, TarGOST® locations at which the maximum response was below 49.1 percent RE can be correlated with nearby soil borings that did not indicate the presence of coal tar. Exceptions are described below.

False positives are defined as locations where the TarGOST® tool indicated the presence of coal-tar NAPL with a response of 49.1 percent RE or greater, but in adjacent borings, other lines of evidence indicate that NAPL is not present in this area. False negatives are defined as locations where the TarGOST® tool was deployed through an interval at which adjacent borings indicated the presence of residual or free-phase NAPL.

The presence of hard, plastic, or soft tar; staining; or odor in adjacent borings is not indicative of a false negative for the TarGOST® tool because the tool is not designed to respond to these materials and characteristics. Similarly, where a pilot hole was drilled through the interval expected to contain NAPL and the TarGOST® tool was used starting below the piloted interval, does not indicate a failure of the tool. Of the 93 TarGOST® borings, six false positives (6.4 percent) and one false negative (1.1 percent) were identified. The rate of these exceptions is consistent with observations made by Dakota Technologies at other coal-tar sites (St. Germain, personal communication, 2006).

**False Positives.** Six borings were identified as exhibiting false positive TarGOST® responses based on visual field observations, historical analytical data, lithology, and analytical data from confirmatory soil samples – TL10-03.5 (maximum TarGOST® response of 53.8 percent RE), TL12-11.75 (maximum TarGOST® response of 50.7 percent RE), TL12.5-11.75 (maximum TarGOST® response of 150 percent RE), TL12.5-12.25 (maximum TarGOST® response of 106.5 percent RE), TL17-07 (maximum TarGOST® response of 50.8 percent RE), and TL18.5-01.5 (maximum TarGOST® response of 87.1 percent RE). In each of these cases, collocated borings did not show the presence of NAPL, and analytical samples, where available, were found to contain low concentrations of coal-tar constituents. All of these borings, except for TL18.5-01.5, contained a clayey peat/native soil layer (“meadow mat”). The elevated TarGOST® response in these borings might indicate interference from the natural organic material associated with meadow mat. At TL18.5-01.5, black silty clay was observed at the depth of the maximum TarGOST® response. Comparison of TarGOST® logs and visual descriptions for these borings are presented in Appendix J.

**False Negatives.** Boring TL16-08 was determined to have peak detection at 37 percent RE (below the minimum TarGOST® response established for the presence of NAPL at OU1). The boring log for the adjacent soil boring MW-112B indicated product (described as low-viscosity) from 4.0 to 8.9 feet bgs. In addition, free-phase coal-tar NAPL has been observed to accumulate in MW-112B..

**Visualization of TarGOST® Results.** Using the Site-specific threshold of 49.1 percent RE, the extent of coal tar was evaluated using the TarGOST® boring results. Only two points were found to have visual and laboratory analytical evidence of coal tar and TarGOST® responses that were above 49.1 percent RE but below 50 percent RE (TL13-02 and TL13-08). To simplify the visualization of the data, the 49.1 percent RE threshold was raised to 50 percent RE and the results were manually adjusted to include these two points within the extent of NAPL in all evaluations.

The maximum TarGOST® response from each location was plotted on a Site plan and contoured using kriging (using Golden Software’s Surfer 8® software). Contours then were manipulated by hand to accommodate the exceptions to the 50 percent RE interpretation as described. Figure 4-1 presents the lateral extent of coal tar as delineated based on the TarGOST® results alone.

The vertical distribution of coal tar using TarGOST® data from each boring was interpolated using a 3D kriging model and the 50 percent RE threshold. Using lithology descriptions from more than 280 soil borings completed as part of the RI for OU1 and various other subsurface investigations (PMK, 2000; EWMA, 2005) at adjacent properties and in River Road, the elevation of the ground surface and the surfaces of key geologic units were created in the model using kriging. Regional bedrock and surficial geologic publications (discussed in Section 3.2) were consulted to determine the accuracy of the surfaces in the model and help develop the bedrock surface west of Gorge Road and beneath the Hudson River. The 3D coal-tar interpolation and geologic surfaces were combined with a base plan depicting surface features at the Site to create a 3D geologic model of the Site illustrating the lateral and vertical extent of coal tar in the subsurface. Figure 4-2 presents several views of the OU1 3D geologic model and depictions of the extent of coal tar. In addition, two-dimensional (2D) cross-sections were cut through the model at various locations throughout OU1 to further illustrate the extent of coal tar. Cross sections A-A' through D-D', developed from the 3D coal-tar interpretation, are included in Figure 4-3.

### Extent of NAPL

A complete delineation of the lateral extent of NAPL at OU1 was obtained by combining TarGOST® results with confirmatory borings and historical visual observations (not only from this RI, but also from the adjacent property investigations). Within this lateral extent of NAPL, TarGOST® data can be used to provide increased resolution and definition of the vertical and lateral extents of the primary deposits of NAPL at OU1, as illustrated in Figures 4-1 through 4-3.

As illustrated in Figure 4-1, the distribution of free-phase and residual coal tar detected by TarGOST® is consistent with the locations of former tanks depicted on historical maps. NAPL is not present as a single contiguous mass. The deepest extents of NAPL are limited to the soil within and above the silty clay confining unit, where present. NAPL has accumulated in natural depressions in the surface of the confining unit (as shown in Figures 3-4b, 4-2, and 4-3), except where NAPL has not yet sunk to the depth of the confining unit or where the continuity and thickness of the confining unit is not fully understood (e.g., adjacent to the shoreline at MW-116DS). Further investigation into the vertical distribution of NAPL in the vicinity of this area has been proposed as part of the SRI.

The majority of NAPL at the Site is present as part of one of five discrete NAPL zones (NZs), (Figure 4-4), which are likely a function of the release mechanisms (tank, piping, or poor housekeeping), varying physical properties (density and viscosity) of the NAPL, the surface of the silty-clay confining unit, and hydraulic conditions. Separate releases of coal tars with different physical properties<sup>10</sup> originating in the central portion of the Quanta property, or a phase separation of the tar subsequent to the release of coal tar in this area, has likely resulted in the layering of coal tar in this area. Four NZs (NZ-1, -2, -3, and -4) have been identified as the primary areas where the majority of residual and free-phase NAPL exists at the Site. These areas were defined on the basis of one or more of following factors:

<sup>10</sup> Coal tar was brought onto the former Barrett Manufacturing property during former manufacturing operations. Although no information is available regarding the source of the coal tar, it is likely that the physical and chemical properties of different batches of coal tar would vary.

- Thickness of visually observed NAPL as well as TarGOST® response indicating NAPL
- Lateral and vertical separation between areas where visual observations and TarGOST® results indicated significant thicknesses of NAPL
- Observation of free-phase (i.e., mobile) NAPL in monitoring wells

One additional NAPL zone (NZ-5) outside the Quanta property boundary that appears to have lesser amounts of NAPL than those described above has also been identified due to its proximity to the Hudson River and the need to evaluate these impacts for the purpose of the remedy selection process.

Although NAPL exists in areas outside these five zones, these areas are generally characterized by the presence of residual NAPL only, or thin discontinuous pockets of free-phase NAPL that cannot be reconciled with the larger NZs, based on the lateral and vertical position in the subsurface relative to the NZs. The purpose of defining these five zones is to make a first attempt at defining generally the areas where most NAPL resides so that their locations and characteristics can be discussed further, in the following subsections. Depending on their characteristics, some of these Zones could be divided further to facilitate the evaluation of varying remedial approaches as part of the FS for OU1. The five zones are described in the following subsections and depicted in Figure 4-4.

**NAPL Zone 1.** NZ-1 comprises the shallower NAPL in the western and central portions of the Quanta property, 115 River Road, and the northern portion of the former Lever Brothers property. NZ-1 consists primarily of two areas of shallow NAPL impacts located generally between 3 and 11 feet bgs. The first area, shown as NZ-1A in Figure 4-4, is in the southwest corner of the Quanta property near the MW-102 and MW-112 series monitoring wells. The second area of NAPL within NZ-1 is shown in Figure 4-4 as NZ-1B and is further east in the central portion of the Quanta property, extending south into the northern portion of the former Lever Brothers property. These two areas of shallow NAPL do not appear to be linked because only deeper, thinner, and more sporadic occurrences of NAPL are present between them at depths between 13 and 23 feet bgs. In addition, several borings between NZ-1A and NZ-1B have shown either no evidence of NAPL or NAPL in thin layers (6 inches or less) at depths greater than 19 feet (MW-114B and TL14-06). Based on this evidence further division of NZ-1 may be warranted as part of the FS for OU1 in order to appropriately evaluate remedial alternatives for NAPL in this area.

Two NAPL samples collected from within NZ-1 (MW-102A and MW-112B) exhibited viscosities of 14.31 and 61.23 cSt, respectively, at 122°F. Interfacial tension in the two samples was measured at 25.0 and 27.5 dynes/cm<sup>2</sup>, respectively. At MW-102B, NAPL in the well has been described as low to medium viscosity and able to flow. At MW-112, NAPL in the monitoring well has been described as medium to high viscosity, and solid “clumps” of NAPL were observed during pumping. NAPL observed in this zone within monitoring well MW-103 has been described in the field as medium to high viscosity; however, no sample of this NAPL was collected for laboratory analysis of physical parameters. At NZ-1, the higher viscosities and interfacial tensions of the NAPL have limited downward vertical migration, and the NAPL has not reached the depth of the silty-clay confining unit, except in an isolated area near former tar USTs (i.e., MW-102B and SB-9). The limited depth of migration of this NAPL compared to the minimum age of the release (36 years) suggests

that vertical migration has generally been limited by the capillary pressures encountered by the NAPL at a depth of 11 feet bgs, or by the presence of meadow mat and/or silty clay deposits.

**NAPL Zone 2.** At the Quanta property, NAPL has been observed in monitoring wells adjacent to the shoreline wooden bulkhead, at depths between approximately 3 and 14 feet bgs. Based on the result of the TarGOST® investigation in this area and west of NZ-2, coal tar here does not appear to be connected to the larger area of coal tar near MW-103 (NZ-3). NZ-2 extends to the north at least as far as the border between the Quanta and former Celotex properties. NAPL samples collected at MW-116B and MW-105 in this zone exhibited viscosities of 27.44 and 181.6 cSt at 122°F, respectively. NAPL at MW-105 was described as sticky, extremely viscous, and difficult to penetrate with a sampling device. Interfacial tension in the two samples was measured at 18.0 and 30.2 dynes/cm<sup>2</sup>, respectively.

NAPL within NZ-2 varies from medium to very high viscosity. As will be discussed in Section 4.1.2, solid tar has also been observed within the extent of NZ-2.

Within the lateral extent of NZ-2 at MW-116DS, NAPL was also observed at a depth of 24 to 25 feet bgs beneath an interval of silty-clay deposits. Further evaluation of the presence of the silty-clay and the deep sand formation at NZ-2 and the occurrence of NAPL above and within these units has been proposed as part of the SRI. The Work Plan Addendum has proposed a series of borings along the length of and adjacent to the bulkhead to evaluate the presence of NAPL in this area. At three locations, borings with continuous soil sampling will be advanced to the top of competent bedrock. Surface and downhole geophysical methods will also be used to determine the depth and lateral extent of the bulkhead relative to observed NAPL. These data will be presented in the Supplemental RI Report for OU1.

**NAPL Zone 3.** Extending from the central portion of the Quanta property south into the former Lever Brothers property beyond the lateral extent of NZ-1, this deeper layer begins at approximately 15 feet bgs and extends into the top few feet of the silty-clay confining unit at approximately 22 to 25 feet bgs. The lower interfacial tension (8.2 dynes/cm<sup>2</sup>) and viscosity (3.49 cSt) of the NAPL sample collected at MW-107 suggest that this NAPL was able to overcome the pore pressures associated with the shallow fill and native sand units to migrate downward and laterally until reaching a natural depression in the top of the undulating surface of the silty-clay confining layer, which limits further migration (Figure 3-4b). In addition, conventional groundwater sampling from monitoring wells between where the “extent of NAPL” is depicted in this area in Figure 4-4 and the Hudson River do not exhibit concentrations indicative of the nearby presence of NAPL (e.g., concentrations in groundwater are less than 10 percent of the solubilities of the compounds detected).

**NAPL Zone 4.** Southwest of NZ-1, beneath Block 93 Central, Block 93 South, River Road, and the northwestern portion of the former Lever Brothers property, NAPL is present in two separate layers: one between 10 and 15 feet bgs and one between approximately 20 and 30 feet bgs. The southwesterly extent of this coal tar has not yet been defined. Coal-tar NAPL was detected at TL12-10.75 at Block 93 South between 14 and 16 feet below grade. Completing the delineation of the extent of coal tar in this area has been proposed as part of the SRI. As part of this additional delineation, NAPL in NZ-4 may be split into shallow and deep subzones to focus the OU1 FS remedy development and evaluation.

**NAPL Zone 5.** Deeper NAPL was identified in borings and by TarGOST® in the southeastern corner of the former Celotex property adjacent to the Hudson River between 18 and 25 feet bgs. NAPL was also identified further west, on the former Celotex property at TL17.5-02 at approximately the same depth and thickness. The silty-clay and deep sand units are absent at these locations because the bedrock surface rises dramatically west of NZ-5. NAPL detected at this location appears to be at the top of the bedrock surface, based on the refusal encountered during RI activities and observations during other investigations conducted in this area (GeoSyntec, 2000b; Parsons, 2005).

Other discontinuous seams of NAPL, evidenced by lower TarGOST® responses and analysis of boring logs from the RI, SI, and work performed by EWMA (2003 and 2004a) and Environ (2005, 2006a, b, 2007), were identified as far as 150 feet to the north of and along the southeastern border of the former Celotex property. The boring logs also suggest the presence of NAPL or Site-related soil impacts extending along the top of the rising bedrock surface further west of TL17.5-02. A review of observations documented in boring logs and the absence of measurable thicknesses in monitoring wells indicate that NAPL in this area is primarily residual.

The latest delineation of these impacts was presented in the “Additional Coal Tar Delineation Report” (Environ, 2007). The coal-tar delineation performed by Environ was conducted under the direct oversight of NJDEP representatives and in accordance with the methods specified in the Administrative Consent Order dated January 26, 2006. These methods specifically were targeted at identifying soils with visual evidence of coal-tar impacts and included not only the presence of NAPL but also any evidence of staining or odors that could indicate coal-tar impacts. The delineation performed by Environ is a delineation of the total extent of coal tar impacts, which includes but is more extensive than a delineation of NAPL. Analysis of boring logs and other data collected must be used in the context of data collected as part of the OU1 RI to determine both the extent of NAPL and the total extent of coal-tar impacts separately. These impacts are delineated in Figure 4-4 and will be discussed as part of the evaluation of the overall extent of soil impacts in Sections 4.3.1 through 4.3.6.

Based on the available data collected to date, it appears that the shallower NAPL observed at the MW-116 series borings may be contiguous with the NAPL observed in NZ-5 (as shown in cross-section D-D’ in Figure 4-3). Conversely the deeper NAPL observed at 24 to 25 feet at MW-116DS does not appear to be connected to NZ-5 as it is present at an elevation of approximately -18 feet above mean sea level (amsl) whereas at NZ-5, NAPL is at approximately -4 feet amsl. This difference in elevation suggests the deeper NAPL observed at MW-116DS does not extend northward as far as the former Celotex property. However, because uncertainty regarding the distribution of NAPL in these areas along the shoreline remains, additional borings adjacent to the bulkhead near MW-116DS and to the north in NZ-5 have been proposed as part of the Supplemental RI to ascertain whether these NZs are contiguous and refine the lateral extent of deeper NAPL observed at MW-116DS.

#### **4.1.2 Solid Tar and Tar “Boils”**

Solid tar was not detected by TarGOST® but was observed during conventional boring activities and excavation activities in support of treatability testing and investigations of preferential pathways. Solid tar has been observed in several soil borings at the Site, most

frequently in the form of a black, soft to stiff, semi-plastic to plastic material at discrete depth intervals with a thickness ranging from 0.3 foot to approximately 6 feet. The thicknesses of 0.3 foot were found in borings located on the Block 93 North property (SB-20, SB-21, and TL 14-09), while the 6-foot thickness was observed at SB-3 on the Quanta property. The inside of the core of this material is often slightly vesicular and has pieces of cinders/coal and other finer material such as sand. The solid tar is found most frequently at depths between 3 to 15 feet bgs on both sides of River Road in borings located near the roadway. Three main areas where the solid tar was observed in borings have been identified: (1) the eastern portion of Block 93 North, (2) the western portion of the Quanta property, and (3) borings near the Hudson River on the Quanta property. Because solid tar was not observed in borings between these areas, solid tar at OU1 does not appear to be contiguous (Figure 4-4).

Surficial tar boils have been observed near borings where solid tar was observed during excavations performed as part of the evaluation of potential preferential pathways on the eastern portion of the Quanta property. Figure 4-4 depicts the locations of borings and excavations in which solid tar was observed as well as the approximate locations of surficial tar boils. In the majority of the borings in which solid tar was observed, black cinder/slag material and/or NAPL were observed in proximity to the solid tar. In borings advanced on Block 93 North, black fabric material (possibly used as matting prior to the placement of fill) was observed (SB-13, SB-22, and SB-23) in the vicinity of the solid tar beneath fill material and in close proximity the top of native materials (e.g. meadow mat). The solid tar most often was observed from 3 to 15 feet bgs. A dense, brittle coal/coal tar was also observed in two areas—in SB-21 and TL 14.5-11.25 from approximately 0 to 4 feet below grade on the Block 93 North property and in surrounding abandoned pipes uncovered at the Quanta property during the preferential pathways investigation from approximately 1 to 5 feet bgs at excavation locations P2 and P3 (shown in Figure 2-4). Similar black fabric material has also been observed at the former Lever Brothers site as part of the environmental investigations being performed at that property.

Soil samples in which solid tar was observed were collected at various depths between 12 and 27 feet bgs. Review of the soil analytical results revealed that the samples collected from intervals in which solid tar was observed each exceeded at least three screening criteria and generally exceeded the lowest criteria for several SVOCs including naphthalene and benzo(a)pyrene, VOCs including benzene and total xylenes, and metals including arsenic and lead. Based on the analytical results, the solid tar potentially appears to be related to former operations at the Site. This correlation is evidenced by the similarity in the suites of compounds that were detected in high concentrations in NAPL samples and the constituents that exceeded their lowest applicable criteria in soil samples from intervals where the solid tar was observed.

### 4.1.3 Former Acid Plant

Based on a review of pertinent historical information, a portion of a former sulfuric acid plant (operated until the mid-1950s) appears to have been located within the extent of the former Quanta Resources property (shown in Figure 1-3). The bulk of these acid plant former operations (approximately 22 acres) were on the former Celotex property, which was recently developed for mixed residential and commercial use. During redevelopment,



arsenic hot spots that were detected during drilling, test pitting, or soil sampling activities were removed or covered with an impermeable liner.

Hudson River Dye Wood Mills began to manufacture sulfuric acid (oil of vitriol) in 1843 in Edgewater (Baptista, 2008). The Mills were purchased by James L. Morgan and Company in 1862. Hudson River Chemical Works' oil of vitriol plant is depicted on an 1876 map of Bergen County (Walker, 1876), south of the James L. Morgan and Company property described above. The map depicts Hudson River Chemical Works north of the Page, Kidder, & Fletcher Chemical Works (tar-processing plant), primarily on what is referred to in this report as the Former Celotex property. Both the Hudson River Dye Wood Mills and Hudson River Chemical Works plants would likely have used the lead chamber process of sulfuric acid production.

General Chemical Company was formed in 1899 and developed the contact process for sulfuric acid production in 1901. By 1903, General Chemical had built a large sulfuric acid production facility in Edgewater (Baptista, 2008). Reigel's *Handbook of Industrial Geochemistry* states, "General Chemical erected a pyrite-burning contact plant using the Herreshoff furnace in 1900" (Kent, 1974). This statement likely refers to this plant because the date is consistent with when this plant was constructed.

A 1958 Fire Insurance map for the acid plant, which was labeled General Chemical, depicts features marked as sulfur ore storage, ore burners, spent acid storage, spent oxide dust collector, and spent oxide cinder conveyor that appeared to extend into the northern portions of the Quanta property. A detailed inspection of the Sanborn® maps (Appendix A) dated 1900 and 1911 reveals the presence of "platina stills."<sup>11</sup> The presence of platina stills means that, at the time the maps were produced, the acid plant used the contact process, not the chamber process, to produce high-quality solutions of sulfuric acid (98 percent), as opposed to the lower-grade of 50 to 60 percent acid solutions that chamber process produced. The mention on the 1958 fire insurance map of "oleum," which is a byproduct produced only by plants using the contact process, also supports the notion that General Chemical was a contact plant, which is consistent with the fact that General Chemical controlled the rights at this time to one of the two most extensively used contact processes in the United States, known as the "Badische process" (DeWolf and Larison, 1921). Contact plants involved processes that required the generation of a consistent grade of particulate-free sulfur gas stream for the production of high-grade sulfuric acid. Additional information regarding former acid plant operations is provided in Appendix N.

### **Pyrite Ore Roasting**

The production process of sulfuric acid at General Chemical would have involved burning elemental sulfur or roasting lump or fine-grained pyrite ore. Based on the presence of "pyrite roasters" on the property, pyrite appears to have been burned as a source of sulfur. Appendix N contains a more-detailed explanation of the processes involved in these operations. Pyrite areas illustrated on the available Sanborn® maps and ore burner areas on the 1958 fire insurance map indicate areas where the chemical plant likely roasted pyrite to create the sulfur necessary for the production of sulfuric acid. Pyrite was roasted as fine pyrite ore or lump ore. Pyrite ore contains not only pyrite (FeS<sub>2</sub>) but also metal impurities

---

<sup>11</sup> "Platina" is a term formerly used to refer to platinum.

such as arsenic, lead, copper, antimony, and thallium. The type of burners used for the contact process was distinctly different from equipment used for the chamber process. For larger operations such as this one, “fines” burners were most common because they had a large capacity with a small footprint, they significantly reduced the labor involved in roasting, and they produced a more consistent product. Contact plants produced higher-grade sulfuric acid (98 percent solutions) and would have used fines in their ore-roasting process to maintain consistency in the sulfur stream.

A major by-product of the pyrite roasting process would have been the iron oxide minerals remaining in the bottom of the roasters after the ore was reduced and all the sulfur burned off (also known as “calcine”). The roasters were fed from the top and mechanically would turn the ore. As it was roasted, the ore was continually reduced, and the remaining cinders would end up at the bottom where the cinders could be retrieved through an outlet. During roasting, pyrite oxidizes into iron oxide minerals, which gives the resulting calcine its characteristic red color (DeWolf and Larison, 1921).

In addition to the calcine, another less-abundant by-product of pyrite roasting operations would have been dust from the burner gas. When fine-grained or powdered pyrite ore was roasted, the resulting gases contained dust that would need to be removed from the process stream to avoid contamination of the product acid and to avoid reduced efficiency of the process. This was the case for both the chamber and contact processes, but was especially important during production of high-grade acids at contact plants. To remove dust from the burner gases, a mechanical device was used to slow or reverse the burner gases and knock out the roasting dust. Washing of the gases was considered inefficient due to the dramatic cooling effect the water had on the burner gases; hence, washing the gas is unlikely to have been done at this plant in any regularity (DeWolf and Larison, 1921). Hydrochloric acid typically was used to scrub impurities that were problematic in the contact process. One of impurities of most concern for contact plants was arsenic, which, if left as a component of the sulfur stream, would significantly reduce the ability to produce high-quality acids. Acid used to scrub these impurities was circulated in scrubber towers until its capacity to remove impurities was reached. Acid also was used to clean lead-lined process piping and tanks. The 1958 Sanborn® Fire Insurance map depicts spent acid tanks, a spent acid unloading area, and dust chamber acid storage tanks. The approximate locations of these features are illustrated in Figure 1-3.

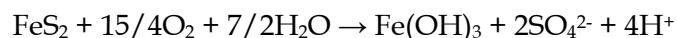
Many acid plants sold the calcine produced resulting from the pyrite process as material for iron blast-furnaces (DeWolf and Larison, 1921). Other reported uses for this material included use in the production of pigments, ceramics, and concrete. Based on the market at the time for calcine and the proximity of the acid plant to significant transportation networks (i.e., rail systems and Hudson River shipping lanes), calcine likely was readily taken offsite for use in other industrial operations.

Features included in the 1958 Sanborn® Fire Insurance map for the General Chemical plant and illustrated in Figure 1-3 show that this plant had a conveyor and elevator for spent oxide cinder (i.e., calcine) that managed and moved this material away from the ore burner buildings. The calcine likely was conveyed to the pier where a 1,500-ton “cinder storage bin” with hoppers used for loading the calcine once existed (also shown in Figure 1-3). This is the same pier where pyrite ore would have been brought to the plant. These materials would have been taken offsite by boat or barge. Figure 1-3 illustrates where the spent oxide

dust was collected at the plant. This material would have been an even finer-grained material that eventually could have been mixed with the calcine. The proximity of the oxide dust collector to the spent oxide cinder elevator suggests that these materials were conveyed to the storage area in conjunction with the calcine.

### Pyrite Ore Roasting Environmental Impacts

Exposure of unburned pyrite ore to rain and moisture results in its oxidation and ultimately produces reddish iron oxide minerals such as hematite and elevated concentrations of iron and the metal impurities of the ore (such as arsenic, lead, copper, antimony, and thallium) in the water as the mineral dissolves. The oxidation reaction of pyrite ( $\text{FeS}_2$ ) can be expressed generally as follows:



In the presence of molecular oxygen ( $\text{O}_2$ ) that can be present in the form of rainwater, the Fe(II) and  $\text{S}_2$ (-II) present as pyrite are oxidized by the  $\text{O}_2$  resulting in ferrihydrite ( $\text{Fe}(\text{OH})_3$ ), dissolved sulfate ( $\text{S}(\text{VI})$ ), and hydrogen ions ( $\text{H}^+$ ). This reaction results in a strong acidic solution that releases impurities such as arsenic. Further changes in pH and Eh conditions can result in the reformation of pyrite (highly reducing) or other minerals. For example, jarosite, expressed as  $\text{KFe}_3(\text{SO}_4)_2(\text{OH})_6$ , would become the primary iron-bearing mineral in this system in the presence of highly oxidizing and low pH conditions. Ferrihydrite is stable over the widest range of pH and Eh conditions.

In the southern portion of the former Celotex property and northwestern corner of the Quanta property, distinct horizons of reddish-purple silt and clay with sand or gravel have been observed. Recently collected samples of reddish-purple soils have been found to contain arsenic concentrations ranging from 648 to 5,870 mg/kg. Historically, arsenic concentrations of up to 35,000 mg/kg have been detected in this material (Raviv, 2002). The extent of these materials has been laterally defined (shown in Figure 4-5) using soil descriptions from boring logs at the Quanta property, as well as data from the former Celotex property, including available boring logs and cross-sections developed by Raviv and presented in the *Groundwater Remedial Investigation Report* for the former Celotex Industrial Park (Raviv, 2004). In this report and in the *Final Soil Remedial Investigation Report* (Raviv, 2002), the area of arsenic concentrations in excess of 1,000 mg/kg is referred to as the "High Concentration Arsenic Area," and the reddish-purple deposits are characterized as fine- to coarse-grained sand and are distinguished as the "lower fill."

Further mineralogical characterization of these reddish-purple soils performed in June 2007 confirmed iron oxide (hematite) was a significant component in these horizons. The presence of pyrite, jarosite, and gypsum also indicate that the reddish-purple soils include unburned or partially burned pyrite that has oxidized in the past and is continuing to oxidize. Jarosite forms when the oxidation of pyrite occurs and conditions become acidic. In the presence of a source of calcium (calcite, dolomite, or plagioclase feldspar), some of the sulfate from the oxidation of pyrite and further oxidation of pyrite and dissolution of jarosite precipitates gypsum. In other words, both the oxidation of pyrite and the dissolution of jarosite produce sulfuric acid that reacts with adjacent minerals forming secondary minerals. Both pyrite and jarosite produce dissolved sulfate or even sulfur, under highly oxidizing conditions. Iron from both minerals eventually forms the reddish-purple

iron oxide mineral, hematite. Near the reddish-purple soils, groundwater consistently has been acidic (pH between 4 and 6). The acidic groundwater and the presence of pyrite, jarosite, and gypsum as intergranular cements within these soils suggest that pyrite oxidation is occurring continuously in the area of these reddish-purple-colored soils.

The “upper fill” that is referred to by Raviv (2002, 2004) on the former Celotex property is a dark brown fine- to coarse-grained sand and silt with wood, brick, and cement fragments that exists at a higher elevation than the reddish-purple fine sands and silts. The upper fill materials likely were placed there upon the demolition of the plant, which occurred sometime between 1953 and 1961 according to historical aerial photographs (Appendix A).

In conclusion, observations of reddish-purple soils and consistently elevated concentrations of various metals correlate well with the historical documentation of the former footprint of the acid plant on the former Celotex property. These reddish-purple layers are found just above and below the water table and are within and underlain by the common fills that dominate the area. These soils do not contain visible slag or cinder (calcine), and, because they do not appear beyond the documented footprint of the former operations, are not likely to be remnants of waste piles. Based on their proximity to the historically documented footprint of the former ore burners and pyrite storage areas, as well as their mineralogical signature, these impacts are likely the result of the oxidation (perhaps through rainwater infiltration and exposure to groundwater) of unburned or partially burned pyrite near where these materials were once stored and handled. No evidence of reddish-purple soils exists outside the historically documented footprint of portions of the former acid plant, suggesting that waste cinders were transported offsite as raw materials to be used in other industrial operations; most likely processed into briquettes for use as iron blast-furnace material (i.e., sintered).

#### 4.1.4 Fill Material

At the Site there are two general types of fill: fill impacted by reddish-purple pyritic material (from the historic sulfuric acid plant operations), and ubiquitous fill used for filling in the property during development. Beyond the area where reddish-purple pyritic-material-impacted soils have been observed (in the area of the former sulfuric acid plant), and across all the properties in the area, fill deposits (consisting of a heterogeneous mixture of gravel, silt, sand, building debris such as concrete and bricks, wood, and other less widely observed constituents such as glass and black cinder, slag and ash) have been documented consistently in boring and test pit logs. The slag, ash/cinder-containing fill deposits are generally thicker, less distinct, and contain a heterogeneous mix of dark-brown and black sand, silt, and gravel with slag, wood and coal cinders and ash, as well as bricks and glass. These materials do not exhibit the same characteristic colors, textures, and mineralogical and chemical compositions as fill observed within the footprint of the former General Chemical Acid Plant, as documented in historical maps including Sanborn® Fire Insurance maps (Appendix A) and were mapped by NJDEP as “Historic Fill” (NJDEP, 2004). The cinders and ash associated with the fill also do not have a reddish-purple appearance (very high concentrations of iron oxide minerals) that would be indicative of roasted pyrite waste generated as part of the operation of the lead chamber or contact process acid plants (i.e., pyrite cinders).

To determine those locations where black heterogeneous slag and/or cinder/ash deposits (as opposed to the reddish-purple soils) were identified during investigations performed at five properties in the area (i.e., former Celotex, Block 93, 115 River Road, former Lever Brothers, and Quanta properties), 390 available soil boring logs were reviewed for any mention of slag, ash, cinder, or reddish-purple discoloration. These observations and interpretations were presented in a technical memorandum submitted to EPA and NJDEP on February 9, 2007, included herein as Appendix N. Table 4-4 provides a summary of information for all the locations where cinder/ash and reddish-purple intervals were observed. An abundance of slag also has been observed adjacent to and within the eroding cut bank along the northern shoreline of the former Lever Brothers property.

In total, 118 locations across the five properties were involved in this investigation where black slag, cinders, and/or ash or reddish-purple discoloration were documented within the soils. Of those 118 locations, 17 had descriptions of reddish-purple horizons (Table 4-4). These 17 areas were located exclusively in the southern portion of the former Celotex property and the northwestern corner of the Quanta property. At the former Lever Brothers property, 32 locations were documented to contain cinders/and or ash. These deposits typically were described as black and, at over 30 percent of these locations, the presence of coal within these deposits was noted. A map showing all the locations where cinders and/or ash were documented is provided as Figure 4-5.

Additionally, mineralogical characterization of these fills was performed across multiple properties in June 2007 to compare these ubiquitous materials to the reddish-purple soils. At Block 93 North (SB-28 through SB-31) and at the former Lever Brothers property near MW-107 monitoring well series (SB-34C) and the slag within the fill along the northern shoreline (SLG-01), the mineralogy is defined by the presence of glass and mullite-rich slag. Unlike the reddish-purple soil, these samples did not contain evidence of pyrite oxidation (pyrite, jarosite, gypsum, and elevated amounts of hematite) (CH2M HILL, 2007i).

The visual appearance of fill containing slag, cinder and/or ash outside the documented historical footprint of the former sulfuric acid plant is distinctly different than pyrite ore impacts within the documented footprint of the former plant. The ubiquitous black slag-rich fill outside this area has the following properties.

- Increased heterogeneity
- An abundance of glassy slag – although generally in lesser amounts, slag was observed in select intervals of reddish-purple soil
- Occurrence in the presence of brick, ash, and coal or coke residue
- Chemical composition that is completely different, with an order of magnitude lower concentrations of arsenic (discussed in further detail in Section 4.3.4)
- Description and chemical composition similar to fill material in other shoreline areas of the Hudson River<sup>12</sup>
- No reddish-purple color that distinguishes pyrite oxidation-impacted materials

---

<sup>12</sup> From the NJDEP imap depicting the “Known Contaminated Deed Notice Sites in Edgewater, New Jersey.

These anthropogenic deposits are likely a result of systematic infilling aimed at raising the topographic elevation of the tidal wetlands that dominated this area along the banks of the Hudson River until the mid-1800s. Coal commonly was used as a domestic heat source and for the generation of industrial power between 1840 and 1920. It was also the source of fuel for trains during this time (Brown and Zdepski, 1994). Ashes and cinders associated with spent coal would have been a readily available and widespread source of material for fill during this time. Slag, a by-product of the smelting of ores, was also a common material used in railroad track ballast and appears to have been a major component of the fill that was used in this area during the development of rail lines and initial industry along the banks of the Hudson River.

Differences in the Hudson River shoreline between maps from 1832 and 1863 indicate that the majority of filling had occurred during the interval of time between the creation of these two maps. Figure 4-6 presents each of these maps overlain on the current U.S. Geological Survey (USGS) 7.5-minute quadrangle and highlights the approximate location of the existing Quanta property. In addition, the surficial geology for the Site has been mapped as “as artificially emplaced sand, gravel, silt, clay, and rock, and man-made materials including cinders, ash, construction materials, and trash” (Stanford, 1993). The NJDEP Land Use Management Division and the New Jersey Geologic Survey also have mapped the Site and surrounding areas as “Historic Fill” as part of the requirements set forth in the “Brownfield and Contaminated Site Remediation Act” (NJSA 58:10B-1 *et seq.*). The NJDEP Historic Fill map is provided in Figure 1-5 and discussed further in Section 3.2 of this report.

Historical fill material in eastern New Jersey has been well documented to contain elevated levels of arsenic, lead, and select PAHs, including benzo(a)pyrene, above residential soil cleanup criteria. For example, the NJDEP Historic Fill Database, as summarized in Appendix D of NJAC 7:26E, indicates that arsenic has been detected in historical fill deposits in New Jersey at concentrations up to 1,098 mg/kg. The background median concentration and 90th percentile concentrations for arsenic in native soils in New Jersey for “Urban Piedmont Soils” (such as at the location of the Site) are 5.2 mg/kg and 24.2 mg/kg, respectively (Sanders, 2003).

As is the case with all other properties along the banks of the Hudson River in this area, these fill materials, unlike the reddish-purple soils discussed previously, are ubiquitous in nature and cannot reasonably be tied to a specific historical operation.

## 4.1.5 Additional Sources

### Identified AOCs at the Former Lever Brothers Property

As part of ongoing investigative and remedial efforts at the former Lever Brothers property, up to 97 AOCs have been identified. NFA has been proposed or granted for 51 of the AOCs. Features associated with AOCs in the northern portion of the property and near Site-related impacts include unknown chemical ASTs, fuel oil ASTs and underground piping, diesel fuel ASTs, a toluene AST, railroad spurs, caustic tanks, transformers, demolition debris, a gas plant, and a P/A-material disposal area. A comprehensive review of the former Lever Brothers property was prepared and summarized in the November 2007 Supplemental RI Report for this property (GZA, 2007b).

Where applicable, the above-mentioned AOCs are discussed in Sections 4.3 and 4.4 as part of the detailed discussions defining the extent of soil and groundwater impacts related to the Site. Three AOCs that appear to have potentially contributed significantly to impacts to soil and groundwater near Site-related soil and groundwater impacts include a former 250,000-gallon fuel oil UST and associated piping, an area of P/A material located in the northern and central portions of the property, and acid tanks located near the MW-107 well cluster. These areas are discussed in more detail below.

**250,000-Gallon Fuel Oil UST and Piping.** A 250,000-gallon fuel oil UST formerly was located in the central portion of the former Lever Brothers property (Langan, 2003-2004). Two lengths of east-west-trending fuel lines used for conveyance of the fuel from ships and to the former boiler house extend approximately 530 feet across the property. Another section of fuel line extended to the north from the northernmost east-west-trending line to within approximately 275 feet of the 115 River Road property to meet a rail spur for fuel delivery purposes. Dry wells that collected condensate from an outer pipe sheathing used to heat oil within the lines with steam are also present near each pipe. Similarly to the northern P/A material area, these dry wells are located to the south of Site-related soil and groundwater impacts. The approximate location of the former 250,000-gallon fuel oil AST and associated piping is illustrated in Figure 1-3.

**P/A Material.** P/A material has been documented by GZA to exist within the fill in central and southern portions of the former Lever Brothers property (GZA, 2006b). P/A material has been found in three distinct forms: “hard pitch that appears brittle at ambient temperatures,” “soft pitch – appears malleable at ambient temperature but would not be expected to flow and migrate with groundwater,” and “liquid pitch – observed to flow at ambient temperature” (GZA, 2007b). In addition to the fill areas, P/A material has been documented by GZA to be present within the riprap along the banks of the Hudson River adjacent to parking lots in the southern portion of the property (GZA, 2007b). Soil and groundwater impacts related to this material include PAHs, select SVOCs, and VOCs in soil and groundwater (GZA, 2007b). Based on the information presented by GZA, the northernmost soft or liquid pitch material is south of Site-related soil and groundwater impacts. Observations of soft and liquid pitch are limited to the central and southern portions of the property (GZA, 2007b, Figure 5). The P/A material is generally attributed to the material that Barrett Division of the Allied Chemical and Dye Company (Barrett) stored on the portion of the former Lever Brothers property that was leased from the then owners. GZA (2007b) states on the basis of a review of aerial photographs from several different years in the 1940s and 1960s that the material that Barrett had stored had been used for fill on the southern portion of the property. However, GZA (2007b) concludes that the origin of the P/A material in the center of the property in between Building 4 and the main site access road is unknown.

Test pits were excavated on March 27, 2008, to further characterize the subsurface in the vicinity of the planned municipal building near the center of the former Lever Brothers property. A CH2M HILL scientist observed the excavation activities and documented the excavated materials and pits. Based on observations made during excavation and a review of the documented evidence, it appears that hard tars and hard tars intermixed with a fabriclike material that were excavated are similar in appearance and physical

characteristics to materials observed in various soil borings on the Quanta property and Block 93.

Although the tarlike materials observed in this area during the test pit excavations appear to be similar to materials observed on the Quanta property and Block 93, their immobility, isolated distribution, and method of emplacement makes them an issue separate from and unrelated to the NAPL plume emanating from the Quanta property, which has been well delineated and terminates in the vicinity of MW-107A. As a result, the horizontal extent of OU1 does not include this material.

**Acid Tanks.** According to the 1900 and 1930 Sanborn® Fire Insurance Maps for the former Lever Brothers property, three “caustic” tanks were located in the Pyle building near where the MW-107 well series currently exists. During the early twentieth century, bases and acids were referred to as “caustic.” Lower pH values for groundwater samples collected from the MW-107 series and surrounding wells suggest a historical release of acid from these tanks might have occurred. In addition, the following AOCs have been documented on the former Lever Brothers property.

- AOC #1e6, a 13,900-gallon acid-wash-water AST
- AOC #1e11, a 2,570-gallon acid-waste chemical AST
- AOC #1e14, five 100,000-gallon hardened, postbleach ASTs

### **Upgradient Source of Chlorinated Solvents in Deep Sand Groundwater**

During groundwater-sampling efforts conducted as part of the RI, certain dissolved-phase chlorinated solvent constituents were detected in groundwater samples collected from the confined deep sand unit. These chlorinated solvents were not observed in the overlying unconfined shallow groundwater. The absence of these constituents in soil and shallow groundwater at the Site, as well as the apparent hydraulic disconnect between the deep sand unit and shallower groundwater (significant upward hydraulic gradients exist from deep sand to shallow groundwater, and the widespread presence of the silty-clay aquitard), suggests that an offsite upgradient source of these constituents exists in groundwater. The nature and extent of these impacts are discussed further in Section 4.4.3.

### **PCBs in Soil at Adjacent Properties**

Low levels of PCBs (less than 2 mg/kg) have been detected in shallow, unsaturated soils (less than 4 feet below grade) within the lateral extents of Site-related impacts. These detections have been observed across both the former Celotex and the former Lever Brothers properties. No other Site-related constituents (such as naphthalene and benzene) have been observed at such shallow depths and at such significant distances from areas of known historical operations related to the Site. Based on their distance from former Site operations, their relatively low levels, and the fact that they are found within the unsaturated zone suggests that the source of these impacts is not related to the Site.

Polychlorinated biphenyls in deeper saturated soils (as deep as 16.5 feet below grade) at the former Celotex property were detected in samples at concentrations as high as 46.4 mg/kg. The distribution of these PCBs is not consistent with other Site-related impacts or historical operations. Due to the relative immobility of PCBs in soil and groundwater, the sources



of these impacts likely are spills related to activities at the former Celotex property, near the area where these impacts have been observed.

### **Rail Lines**

Rail lines once ran throughout this area as part of industrial operations and are associated with the Site as well as industrial activities at all the adjacent properties. The location of former rail lines within and adjacent to the Site are shown in Figure 1-3. Rail lines built between the mid-1800s to mid-1900s such as those that were located throughout this area were built on engineered fill materials that often contained coal, coal ash, and slag. In addition, spillage from coal cars and disposal of coal ash could have resulted in deposition of these materials onto the rail beds. These materials have shown to contain highly variable concentrations of PAHs and metals (including arsenic, barium, selenium, beryllium, and vanadium). The concentration of these constituents depends on the origin of the coal and the efficiency of its combustion (Brown and Zdepski, 1994).

## **4.2 Constituents of Interest**

Constituents of interest were developed for soil and groundwater by screening analytical results against various soil and groundwater criteria, as described in the following subsections.

### **4.2.1 Soil COIs**

For the purpose of evaluating the soil data collected as part of the RI, as requested by EPA, laboratory results for all chemical constituents were screened against the following soil criteria:

- New Jersey Residential Soil Cleanup Criteria (NJDEP, 1999)
- New Jersey Nonresidential Soil Cleanup Criteria (NJDEP, 1999)
- New Jersey Impact to Groundwater Soil Cleanup Criteria (NJDEP, 1999)
- EPA Region 9 Industrial Soil Preliminary Soil Remediation Goals (PRGs) (EPA, 2004)
- EPA Region 9 Residential Soil PRGs (EPA, 2004)

All RI soil data that CH2M HILL collected between 2005 and 2006, historical samples collected at OU1 prior to RI activities, and samples collected during environmental investigations at adjacent properties and near the Site between 2003 and 2007 were compared to the five screening criteria listed above. In total, 856 soil samples were evaluated against the soil screening criteria summarized in Table 4-5. Those constituents for which there was an exceedance of the lowest soil criteria were considered COIs in soil for the purpose of this assessment. Table 4-6 lists the COIs in soil for PAHs, non-PAH SVOCs, VOCs, inorganics, pesticides, and PCBs and summarizes the screening results for each RI soil sample collected at the Quanta, former Celotex, 115 River Road, and former Lever Brothers properties, as well as at portions of Block 93 (west of River Road). The lowest values of the applicable soil screening criteria also are provided in Table 4-6. Laboratory analytical results tables for all RI soil samples evaluated in this report are provided in Appendix C. Analytical laboratory reports for the soil samples are included in Appendix D.

The COIs listed in Table 4-6 consist of SVOCs (predominantly PAHs), VOCs (benzene, ethylbenzene, styrene, and xylenes), iron, lead, and arsenic. In addition, a limited number of low-level detections of chlorinated solvents (trichloroethylene [TCE], tetrachloroethylene [PCE], and vinyl chloride) and some low-level PCBs in excess of the lower of the PRGs and New Jersey Residential and Non-Residential Soil Cleanup Criteria (NJSCC) were observed during RI sampling activities. Limited exceedances of select metals (antimony, barium, beryllium, chromium, copper, mercury, nickel, selenium, thallium, vanadium, and zinc) also were observed. These constituents have been included in the list of COIs for the purpose of this evaluation.

## 4.2.2 Groundwater COIs

For the purpose of evaluating the groundwater data collected as part of the RI, as requested by EPA, laboratory results for all chemical constituents were screened against the following groundwater criteria:

- Higher of the Groundwater Quality Criterion and the Practical Quantitation Limit presented for each constituent in Appendix Table 1 of Chapter 7:9C of the NJAC. For those constituents that do not currently have a GWQS, an interim generic groundwater quality criterion was used in accordance with NJAC Section 7:9C-1.7 (C)(6).
- Region 9 Tap Water PRG (EPA, 2004)

All RI groundwater data that CH2M HILL collected between 2005 and 2006 were compared to the screening criteria indicated above.<sup>13</sup> These screening criteria values are listed in Table 4-7. The lower of the applicable criterion for each constituent will be referred to herein as the groundwater quality criterion (GWQC). Those constituents that were detected in groundwater during any of the 2005-2006 groundwater sampling events at or above their GWQC have been considered COIs in groundwater. Table 4-8 lists these constituents along with the applicable GWQC and indicates during which sampling events exceedances were detected at each well. Laboratory analytical results tables for all RI/FS groundwater samples analyzed for these constituents are provided in Appendix F. Lab reports for groundwater sampling analyses are included in Appendix D of this report.

The COIs listed in Table 4-8 consist of SVOCs (predominantly PAHs), VOCs (BTEX, chlorinated VOCs, and styrene), ammonia, arsenic, iron, and lead. In addition, a limited number of low-level detections of pesticides in excess of the applicable GWQC were detected.

## 4.3 Soil

### 4.3.1 Polycyclic Aromatic Hydrocarbons

Consistent with previous soil sampling events in and around the Site, soil samples collected during RI activities indicate the presence of PAHs in unsaturated and saturated soil throughout the Site. PAHs were not detected above the screening criteria in soil samples collected from the deep sand unit beneath the silty-clay aquitard. Figures 4-7 (3 sheets) and

<sup>13</sup> The values in these screening criteria are at or lower than the federal Safe Drinking Water Act maximum contaminant levels for drinking water.

4-8 (4 sheets) present the highest detected concentration of each PAH that exceeds its lowest applicable soil screening criterion for 0 to 4 feet bgs and for greater than 4 feet bgs for each soil sampling location evaluated.

Determination of the extent of PAHs in soil related to the Site was undertaken in consideration of the documented and ubiquitous presence of fill material throughout the unsaturated and saturated zones at the Site and across all adjacent properties. The materials documented in boring logs across all the properties near the Site that are associated with these fills (e.g., wood ash, coal, coal ash, and cinder) are known to contain significant concentrations of PAHs. Due to this widespread additional source of PAHs unrelated to the Site, delineation of soil concentrations of these constituents to concentrations less than the applicable soil screening criteria was not feasible. Instead, multiple lines of evidence using the TarGOST® coal-tar delineation and the distribution of other Site-related constituents in soil not typically found in historical fills (e.g., naphthalene) was developed to estimate the minimum concentration of key indicator parameters in soil that likely represents Site-related impacts.

### **Benzo(a)pyrene**

The PAH most frequently detected above its applicable soil screening criteria (643 of 856 detections, 75 percent of the soil samples analyzed) is benzo(a)pyrene. To illustrate the lateral distribution of Site-related PAHs, the highest concentration of benzo(a)pyrene in unsaturated soil (0 to 4 feet bgs) and saturated soil (4 feet bgs and deeper) at each sampling location was plotted and contoured and are shown on Figures 4-9 and 4-10, respectively. Concentrations greater than 10 mg/kg of benzo(a)pyrene in soil appear to be representative of impacts related to the Site.

Concentrations of benzo(a)pyrene up to two orders of magnitude greater than most of those detected to the north and south of the Site are observed in the soils of the unsaturated and saturated zones throughout the Quanta property. The greatest of these impacts (greater than 1,000 mg/kg of benzo(a)pyrene) occurs along the eastern border of the Quanta property in both saturated and unsaturated soils adjacent to the wooden bulkhead. Elevated concentrations of benzo(a)pyrene extend approximately 380 feet to the north of the Quanta property boundary on former Celotex property where a sample collected from soil boring C-98-3 (completed in 1997) indicated 819 mg/kg of benzo(a)pyrene in soil between 7.5 and 8 feet bgs (Parsons, 1997). This soil sample was collected 10 years ago in 1997, and thus does not represent current conditions. It should also be noted that soils near C-98 have been excavated (EWMA, 2000). A TarGOST® boring advanced approximately 30 feet to the south of this location (TL19-0.5) did not indicate the presence of coal tar, and confirmatory soil sampling at the highest TarGOST® response interval at this location revealed a concentration of benzo(a)pyrene of 2.28 mg/kg at 28 to 29.5 feet bgs. Additional TarGOST® borings advanced to the north and west of historical boring location C-98 confirmed that coal-tar impacts do not extend beyond this location.

Recent additional investigation on the former Celotex property confirms that the extent of NAPL impacts in soil has been defined. According to previous investigations, the northernmost NAPL impacts are just to the south and beneath the edge of the overhanging parking lot structure, and are isolated as a thin layer of observed residual staining above the shallow bedrock surface (Environ, 2006a and 2006b). North of the Quanta property, farther

from the Hudson River, the extent of elevated PAHs in soil do not extend as far north. Specifically, analytical data in this area show elevated concentrations of benzo(a)pyrene in soil samples collected from borings SS-19.5D (12 to 13 feet bgs) and SS-19B2 (11.5 to 12 feet bgs) of 11 and 33 mg/kg, respectively (Environ, 2006a and 2006b). Additional soil sampling performed by Environ just to the north, west, and east of these locations, as well as the results from the TarGOST® investigation and concentrations of coal-tar-related constituents do not suggest NAPL is present beyond the location described. Farther west on the former Celotex property, PAHs in soil are limited to 150 feet north of the Quanta property boundary in the central portion of the property (east-west) to approximately 40 feet to the north of the Quanta property boundary at the western edge of the property along River Road, as indicated in Figure 4-8, sheets 3 and 4, which show analytical results for borings used in this delineation.

Concentrations of the representative PAH, benzo(a)pyrene, that are above screening criteria extend from the Quanta property to the west beneath River Road and into portions of Block 93 North, Central, and South (shown in Figure 4-8). To the south of the Quanta property, elevated concentrations of benzo(a)pyrene in saturated soil extend from the Quanta property beneath the 115 River Road property onto the northern portions of the former Lever Brothers property. Discontinuous areas of PAHs in unsaturated soil with concentrations slightly above 10 mg/kg exist in the northern portion of the former Lever Brothers property. Additional evaluation of this area has been proposed as part of the SRI.

Still farther south of the Quanta Property, in the central portion of the former Lever Brothers property, elevated concentrations of PAHs have been detected in saturated soil boring GZA-89. Benzo(a)pyrene concentrations in soil in saturated soil samples collected at GZA-89 are as high as 1,800 mg/kg. These impacts are not related to the Site and have been documented to be due to the presence of a source of P/A material in this area (GZA, 2006b and 2007b).

On the 115 River Road and former Lever Brothers properties along the Hudson River, concentrations of benzo(a)pyrene of up to 280 mg/kg in unsaturated soil extend 150 feet to the south of the Quanta property boundary on 115 River Road and portions of the former Lever Brothers property. These soil impacts extend inland from the Hudson River approximately 150 feet. Figures 4-9 and 4-10, respectively, present isoconcentration contours and the extent of benzo(a)pyrene in soils above and below 4 feet bgs (i.e., in unsaturated and saturated zones). Still farther to the south, concentrations of benzo(a)pyrene as high as 110 mg/kg at MW-109A (7.0 to 7.5 feet bgs) have been detected in saturated soils. These impacts are believed to extend to the bank of the inlet to the south of boring MW-109A. Based on historical aerial photos and tax assessor's maps (shown in Appendix A) for the Borough of Edgewater, this area was formerly part of the Hudson River and was claimed through filling sometime between 1961 and 1970 (Figure 1-3).

### **Naphthalene**

Naphthalene, a low molecular weight PAH associated with coal tar and not typically found at elevated concentrations in historical fill deposits, has a slightly different distribution in soil than that of the heavier-end PAHs such as benzo(a)pyrene, which is a common component of both coal tar and regional fill material. Figures 4-11 and 4-12 illustrate the distribution of naphthalene in unsaturated and saturated zone soils, respectively.

Naphthalene concentrations above the applicable soil-screening criterion of 56 mg/kg in the unsaturated deposits are generally found within the boundaries of the former Quanta Resources property and extend from the wooden bulkhead along the Hudson to the east under River Road and within the eastern portions of Block 93 North. Within the Quanta property are elevated concentrations of naphthalene of up to five orders of magnitude greater than those seen at the adjacent properties to the north, south, and west. These elevated concentrations of naphthalene in unsaturated soil range from 2,600 to 10,000 mg/kg and are found near SB-112A, SB-06, and SB-03 between 0 and 4 feet bgs.

Figure 4-12 illustrates the distribution of naphthalene concentrations in soil at and below 4 feet bgs (saturated soil). The majority of exceedances and highest concentrations are found along the southern and western boundaries of the Quanta property where concentrations range from 890 mg/kg at SB-01 to 10,200 mg/kg at boring TL14-09, as shown in Figure 4-12. Additional exceedances of screening criteria for naphthalene in saturated soil appear to be concentrated along the northern border of the Quanta property and the southernmost portion of the former Celotex property (Figure 4-12). Unlike in unsaturated soils, the distribution of naphthalene as measured in saturated soils is a result of its migration in groundwater, both as a component of the NAPL and in the dissolved phase, rather than as a direct result of spills that occurred at one time in the area. .

In general, the lateral extent of exceedances of naphthalene in saturated soil does not extend as far as that of benzo(a)pyrene (Figures 4-9 and 4-10). The one exception is in the central portion of Block 93 North where concentrations of naphthalene in saturated soil samples above soil screening criteria extend farther westward. Specifically, soil samples collected from borings SB-27 and 3Y-14 contained concentrations of 101 and 77.5 mg/kg, respectively (shown in Figure 4-8, sheet 4). Additional soil sampling to the north, west, and south of these locations confirms that the extent of these impacts has been defined.

Three soil samples were collected from the deep sand unit beneath NAPL-impacted areas: at SB-101DS, SB-103DS, and SB-107DS (identified in Figure 2-2). No exceedances of screening criteria for any PAHs were observed in these samples. With the exception of low levels in the sample collected from SB-103DS, PAHs were not detected above laboratory method detection limits in any of the samples collected from the deep sand deposits.

With the exception of both the unsaturated and saturated soils in the western and southern portions of the Block 93 North, Block 93 Central, and Block 93 South, the lateral and vertical extents of PAHs in exceedance of the soil screening criteria that are believed to be related to former operations associated with the Site and nearby non-Site related operations (i.e., rail lines, iron foundry, and historical fill material) has been defined. Completion of the delineation of the extent of Site-related PAHs in soil in this area has been proposed as part of the SRI.

### 4.3.2 Semivolatile Organic Compounds

Non-PAH SVOCs detected in soil samples above respective applicable soil screening criteria are: 2,4-dimethylphenol, 2,4-dinitrotoluene, 4-methylphenol, 4-nitroaniline, bis(2-ethylhexyl)phthalate, carbazole, dibenzofuran, and phenol. Figures 4-13 and 4-14, respectively, present the maximum detected concentration of each SVOC (not including PAHs) exceeding the lowest applicable soil screening criterion for 0 to 4 feet bgs and for 4

feet and below for each soil sampling location evaluated as part of the RI. Of these eight constituents, only carbazole and dibenzofuran were detected in more than 3.6 percent of the total number of samples analyzed for the constituent (up to 556 soil samples). Carbazole and dibenzofuran have been detected in samples of NAPL collected at the Site.

### **Dibenzofuran**

For dibenzofuran, of which 7.1 percent of a total of 508 soil samples exceeded the Region 9 Residential PRG of 150 mg/kg, the highest concentrations (between 1,000 mg/kg and 2,800 mg/kg) are generally located in the western portion of the Site in samples beneath the water table with visual or other evidence of Site-related NAPL impacts (SB-02, SB-03, SB-116, TL18.5-0.5, and T-8\_2). Dibenzofuran was also detected at 1,080 mg/kg between 10 and 12 feet bgs at TL14-09 in the southwestern corner of the Quanta property where the presence of coal tar has been confirmed. All SVOC exceedances found at depths of 4 feet bgs and below are presented in Figure 4-14. Lower concentrations of dibenzofuran detected above soil-screening criteria have been identified in unsaturated soil west of River Road at Block 93 North (SB-10, SB-11, SB-21, SB-23, and TL14-10.75). Exceedances in saturated soil in this area extend farther west into the central portion of Block 93 North where a concentration of dibenzofuran was detected in soil from 10 to 12 feet below grade slightly above the screening criteria at 170 mg/kg. Other exceedances were detected in saturated soil on the 115 River Road property at soil borings SB-08 and SB-17 and in the southern part of former Celotex property at borings SB-X12, C-46, C-57, and C-98. All saturated soil borings and the highest constituent analytical results for compounds that exceeded criteria are shown in Figure 4-14. Soils have been excavated near borings C-46 and C-98 areas as part of remediation associated with the former Celotex Industrial Park (EWMA, 2000). In general, the distribution of dibenzofuran in both unsaturated and saturated soil is very similar to that of naphthalene. Exceedances of the applicable soil screening criterion for dibenzofuran are always found in the presence of elevated concentrations of naphthalene.

### **Carbazole**

Carbazole was detected above its applicable soil screening criterion (Region 9 Residential PRG is 24 mg/kg) in 13.8 percent of the 522 samples analyzed for this constituent. Carbazole detections in soil above the screening criterion ranged between 24.7 mg/kg at SB-W21 in the southern portion of the former Celotex property and 1,200 mg/kg at SB-03 in the western portion of the Quanta property. Similar to dibenzofuran, elevated concentrations of carbazole (greater than 400 mg/kg) are found in soil samples containing evidence of NAPL. In addition, the lateral and vertical extents of exceedances for carbazole are within the extents of naphthalene exceedances in soil.

Semivolatile organic compounds were not detected above applicable soil criteria in samples collected from the deep sand unit. With the exception of low levels of bis(2-ethylhexyl)phthalate in the sample collected from SB-103DS (Figure 4-14), all remaining SVOCs were below laboratory method detection limits in all samples collected from the deep sand unit.

### **4.3.3 Volatile Organic Compounds**

Volatile organic compounds detected at or above the soil screening criteria are: benzene, xylene (total), ethylbenzene, methylene chloride, styrene, PCE, TCE, and vinyl chloride.

Figures 4-15 and 4-16, respectively, present the highest detected concentration of each VOC exceeding the applicable soil screening criterion for 0 to 4 feet bgs and for 4 feet and below for each soil sampling location evaluated as part of the RI. Of these eight constituents, only benzene and total xylene were detected above screening criteria in at least 5 percent of the samples analyzed, which included as many as 467 soil samples. Each of these constituents has been detected in NAPL samples from the Site.

Three soil samples collected from the deep sand deposits at SB-101DS, SB-103DS, and SB-107DS (identified in Figure 2-2) indicated that all VOCs were below soil-screening criteria. VOCs detected in the deep sand unit below screening criteria included ethylbenzene, toluene, and xylene at SB-103DS and low levels of TCE at SB-103DS and SB-101DS (Figure 2-2). All other VOCs for which analyses were performed in the deep sand samples were below the laboratory method detection limits.

### Aromatic VOCs

Concentrations of benzene in soil between 0 and 4 feet bgs (unsaturated) and in soil greater than 4 feet bgs have been plotted and contoured in Figures 4-17 and 4-18, respectively. For benzene, of which approximately 20.8 percent of a total of 467 soil samples exceeded the EPA Region 9 PRG of 0.64 mg/kg, exceedances in unsaturated soils appears to lie within the extent of the former Quanta property (Figure 4-17). The isolated areas where surficial tar has been observed on the Quanta property are within or close to the area where benzene concentrations in unsaturated soil exceeded the EPA Region 9 PRG.

Based on the isoconcentration contours for saturated soil (shown in Figure 4-18) and the extent of NAPL (shown in Figure 4-4), the area of benzene exceedances in soil is similar to those areas in which NAPL exists. Several discrete areas of elevated benzene concentrations in saturated soil exist at the Site where concentrations were detected at an order of magnitude or more above the EPA Region 9 PRG and NJDEP proposed soil cleanup criterion.<sup>14</sup> These areas are as follows (identified in Figure 4-18).

- Southeast corner of the former Celotex property (SB-W21, SB-W24, and TP-10)
- South-central portion of the Quanta property and north-central portion of the 115 River Road property (SB-02B and MW-121B)
- A larger area extending west-northwest from MW-114B covering most of the western portion of the Quanta property and TL 14-10.75 on the southeastern portion of Block 93, Lot 3

Another small area of benzene with concentrations of 2.2 mg/kg or less in the saturated soil is found on the former Lever Brothers property. Impacts in this area are not associated with Site-related historical activities but instead are related to the presence of the P/A material documented to exist in this area (GZA, 2006b).

The extent of benzene impacts in soil has been delineated across the Site other than to the south of TL 12-10.75 on Block 93 (Figure 4-18). This delineation has been proposed as part of a supplemental investigation.

---

<sup>14</sup> The lowest of the NJDEP Residential, Non-Residential, and Impact-to-Groundwater Soil Cleanup Criteria

Aromatic VOCs other than benzene were generally less frequently detected and are located within the horizontal extent of the benzene detections. Additional aromatic VOCs detected above their lowest respective applicable criterion include ethylbenzene, styrene, and xylene with 2.2, 0.5, and 7.7 percent of samples exceeding the lowest screening criterion, respectively. Ethylbenzene, styrene, and the majority of xylene concentrations above screening criteria were detected in saturated soil at or below 4 feet bgs (shown in Figure 4-16).

### **Chlorinated VOCs**

Chlorinated VOCs were detected in soil samples intermittently across the Site and surrounding properties during RI investigation activities, predominantly in saturated soil samples. No chlorinated hydrocarbon NAPL has been observed at the Site nor do any of chlorinated organic compound concentrations observed in groundwater at the Site approach the EPA “Rule of Thumb” of 1 percent of the effective pure-phase solubility for any these compounds, which would suggest the presence of chlorinated solvent NAPL (EPA, 1992a).

Methylene chloride, PCE, TCE, and vinyl chloride were detected at concentrations above NJ IGWSCC and EPA Region 9 Residential PRG screening criteria. Each of these constituents was detected above screening criteria in less than 2 percent of the 463 samples analyzed for these parameters. The highest concentrations of methylene chloride and PCE were identified in samples of saturated soil at the former Celotex property in historical borings at concentrations of 3.7 mg/kg (at TP-14) and 3.2 mg/kg (at TP-14), respectively, which appear not to be Site-related. The highest concentration of TCE in soil was detected in shallow soil at historical boring B-8-90 on the Quanta property at a concentration of 0.54 mg/kg. Vinyl chloride was detected above the lowest soil screening criteria at one sample collected at the water table on the former Lever Brothers property (SB-120B) at a concentration of 0.07 mg/kg and does not appear to be Site-related.

Chlorinated VOCs were detected less frequently in soil at the Quanta property compared to the adjacent properties, with the majority of the detections being in soils at the former Lever Brothers and former Celotex properties. The infrequent and low-level detections along with the irregular distribution of chlorinated solvents in soil suggest that no known ongoing source of these constituents exist related to the Site.

An upgradient source of chlorinated VOCs is suspected to be impacting the confined groundwater zone beneath the Site based on easterly groundwater flow, as shown in Figure 3-6. Possibly some cases of the detection of these constituents in soil could be the result of repartitioning from groundwater to soils with higher organic content after migrating from an upgradient source via groundwater.

#### **4.3.4 Inorganic Constituents**

Figures 4-19 and 4-20 present the highest detected concentration of each inorganic constituent exceeding its respective applicable soil screening criterion for 0 to 4 feet bgs and for 4 feet and below for each soil sampling location evaluated as part of the RI. Inorganic constituents exceeding applicable soil criteria consisted exclusively of metals. A total of 14 metals were detected in one or more sample above its lowest soil-screening criterion (listed in Table 4-6).



Based on an evaluation of slag-, cinder/ash-, and pyrite-impacted soils, two distinct potential sources of elevated concentrations of metals in soils are present at the Site. One of the sources is the fill material – partially composed of black slag, cinders and/or coal ash – present across all the properties. These materials have been documented in more than 100 boring logs from borings located on the five properties including the Quanta property. The other source of elevated metals concentrations are the reddish-purple soils that are the result of oxidation of pyrite ore associated with the former acid plant operations. Locations where these two source materials have been observed are illustrated in Figure 4-5. The mapped historical footprint of this former facility lies partially on the northwestern portions of the Quanta property with the remainder on the former Celotex property. Detailed information about the former acid plant processes, the characteristics of associated impacts, and the associated delineation effort can be found in Appendix N.

Additional sources of metals not identified herein possibly could exist on adjacent properties, such as potential impacts associated with the former rail lines throughout the area. As mentioned in Section 4.1.5, the Site also could contain metal impacts related to existing and historical rail lines that once ran throughout this area. None of these sources are related to the former operations associated with the Site; however, the extent of impacts within the Site boundaries has been defined such that these impacts could be addressed during remedial design efforts targeted at Site-related constituents.

As part of the SI, soil sampling was performed at several locations at the Site where further analytical characterization of arsenic and other metals was deemed necessary to assess the nature and extent of various potential sources of these constituents (CH2M HILL, 2006d). This work involved the collection and analysis (for TAL metals and TAL metals using SPLP) for 10 reddish-purple soil samples near the former acid plant in the northwest portion of the Quanta property, where elevated concentration of metals previously had been observed in the absence of the reddish-purple soils at Block 93 North (for TAL metals only). In addition to the SI scope, analytical data for soils sampled by others at adjacent properties were obtained, which are included in the Site database to assist in the evaluation of spatial trends of the constituents detected above regulatory screening criteria at OU1. The results of this work and the subsequent evaluations were presented and discussed in a technical memorandum submitted to EPA (CH2M HILL, 2007b; Appendix N).

Following the presentation of the results of SI metals sampling, additional mineralogical characterization of the reddish-purple soils and cinder/slag containing fill deposits was performed. This work was performed in June 2007 and involved the completion of 9 soil borings in areas of known soil and groundwater impacts. The mineralogy and chemical composition of distinct intervals of the cinder/slag deposits and the reddish-purple soils were characterized using XRD, Thin Section Petrography, TAL metals, and TAL metals using SPLP. Results of this work were presented and discussed in the *Characterization of Cinder/Ash and Reddish-Purple Soils – Field Work Summary and Analytical Results Discussion* (CH2M HILL, 2007i; Appendix N).

As more thoroughly discussed in Section 4.1.3 and Appendix N, the ubiquitous fill deposits are distinctly different than the observed reddish-purple soil impacts within the mapped historical footprint of portions of the former acid plant (i.e., pyrite storage, ore burner operations, and spent acid storage areas) and are discussed in more detail in this document. To evaluate if a qualitative difference exists between these two materials with respect to

their chemical composition, a review was performed of the available analytical data for those locations where boring logs mentioned the presence of ash, cinders, or reddish-purple soils as indicated in Table 4-4. Specifically, laboratory soil analytical data for metal analyses were compiled for the five properties of interest in and around the Site. Including the latest results from the SI described herein, a total of 82 samples of these materials were evaluated.

The results of the SI soil sampling analyses are summarized below and presented in Table 6 of Appendix N (CH2M HILL, 2007b). The discussion below summarizes the laboratory results from the additional characterization of these materials. Tables 5A through 5D of the *Characterization of Cinder/Ash and Reddish-Purple Soils – Field Work Summary and Analytical Results Discussion* present those results (CH2M HILL, 2007i; Appendix N).

Of the 82 soil samples from the five properties that were evaluated in the investigation, 13 were of distinctly reddish-purple impacted intervals within the mapped historical footprint of the former sulfuric acid plant. These 13 samples included 9 from the Quanta property and 4 from the former Celotex property. The remaining 69 soil samples represent all documented observations of slag, cinder, and/or ash containing fill intervals without any indication of reddish-purple discoloration (i.e., pyrite oxidation impacts) that, at a minimum, were sampled for arsenic. Locations where reddish-purple soils and fill have been observed are shown in Figure 4-5.

Comparison of the geometric mean concentrations of metals between the two data sets indicated that antimony, arsenic, copper, lead, and thallium concentrations are consistently an order of magnitude higher in the reddish-purple soil samples. Further statistical evaluations using means tests confirmed that concentrations of these metals, in addition to those of mercury and selenium, were statistically higher in the reddish-purple soils within the mapped historical footprint of the former acid plant operations. Conversely, concentrations of aluminum, chromium, manganese, magnesium, nickel, and vanadium in soil were found to have statistically higher concentrations in slag, cinder/ash fill deposits than those found in the reddish-purple soils. Results of these statistical evaluations are presented in Table 4-9.

Further discussion on the nature and extent of the metals that exceeded the lowest soil screening criteria for one or more sample evaluated during the RI is provided in the following sections in context of known sources.

### **Antimony**

Concentrations in soil ranged from 15.7 to 205 mg/kg in unsaturated soil, and 14.7 to 145 mg/kg in saturated soil; screening criteria range from 14 to 410 mg/kg (NJDEP, 1999; EPA, 2004). The highest concentrations are found in the northern portion of the Quanta property within the documented historical footprint of the former acid plant along the northwestern property boundary. These elevated concentrations extend onto to the former Celotex property within the mapped historical footprint of former acid plant operations. Exceedances of antimony also were detected in a small area of shallow soils between 1 foot and 3 feet bgs at Block 93 North. Other concentrations of antimony that are not related to historical Site operations were observed at the former Lever Brothers property.

## Arsenic

Arsenic in unsaturated soil (including fill) above screening criteria, which range from 0.39 to 20 mg/kg (NJDEP, 1999; EPA, 2004), was observed across all the properties at concentrations ranging up to 35,100 mg/kg. Arsenic was detected at concentrations above its lowest criterion in 95 percent of samples collected. Arsenic isoconcentration contours were plotted for unsaturated and saturated soils and are presented in Figures 4-23 and 4-24, respectively. Review of these figures reveals that concentrations greater than 100 mg/kg of arsenic in unsaturated soil were detected in the northwestern portion of the Quanta property, in several areas at Block 93 North, and around soil boring GZA-24 in the central portion of the former Lever Brothers property. Concentrations of arsenic above 100 mg/kg were observed in soils greater than 4 feet bgs throughout the former Celotex property, the northern and central portions of the Quanta property (west of the MW-103 cluster), the central and eastern portions of the 115 River Road property, and at several locations at the former Lever Brothers property (shown in Figure 4-24).

Arsenic concentrations in the northwest corner of the Quanta property and the southwestern portion of the former Celotex property (within the mapped historical footprint of the former acid plant) are at least one order of magnitude higher than anywhere else outside these areas and are often described as reddish-purple in color. Arsenic concentrations in the southwestern corner of the former Celotex property are at similar topographic elevations as those that are seen in shallower soils in adjacent portions of the Quanta property, due to significant filling (as much as 15 feet) during redevelopment of the former Celotex property. Concentrations of arsenic above 1,000 mg/kg at the former Celotex property were removed during hot-spot excavations or covered beneath an impermeable liner during the construction of City Place as part of remedial actions for this property (Raviv, 2002, 2004, 2005). Excavation activities involved the removal of soil from in and around borings C-4, 45, 46, 47, 48, 50, 77, 79, 98 and T-5. Because these arsenic-impacted soils have been removed, they are not included in soil isoconcentration contouring of arsenic in Figures 4-23 and 4-24. Concentrations of arsenic outside the documented historical footprint of the former acid plant range between nondetect and 988 mg/kg.

## Barium

In soil sample analyses for barium, none of the samples collected during the RI or SI exceeded screening criteria, which range from 700 to 67,000 mg/kg for barium (NJDEP, 1999; EPA, 2004). One sample collected from a discrete interval of saturated reddish-purple soil in the northwest portion of the Quanta property (SB-36) during the June 2007 activities for characterization of soils had a barium concentration of 758 mg/kg, which is slightly above the lowest soil-screening criterion.

## Beryllium

Concentrations in soil ranged from 3.45 to 4.1 mg/kg in unsaturated soil, and 5.8 to 565 mg/kg in saturated soil; applicable NJDEP and EPA screening criteria for beryllium range from 2 to 1,900 mg/kg (NJDEP, 1999; EPA, 2004). The highest concentrations were found on the northern portion of the former Celotex property. Lower-level exceedances of beryllium in soil (3.45 to 5.8 mg/kg) were detected at two locations at Block 93 North and at one historical sample location at the Quanta property.

## Chromium

Two samples collected on the former Lever Brothers property independent of the RI/FS exceeded screening criteria for chromium, which range 210 to 450 mg/kg (NJDEP, 1999; EPA, 2004). None of the samples collected during the RI, SI, or Characterization of Cinders and Reddish-Purple Soils exceeded screening criteria for chromium.

## Copper

Concentrations in soil ranged from 1,530 to 9,690 mg/kg in unsaturated soil, and 655 to 31,300 mg/kg in saturated soil; applicable NJDEP and EPA screening criteria for copper range from 600 to 41,000 mg/kg (NJDEP, 1999; EPA, 2004). The highest concentrations are found in the northern portion of the Quanta property and onto to the former Celotex property within the mapped historical footprint of the former acid plant property. Copper concentrations in soil do not exceed the lowest soil criterion outside areas associated with former acid plant operations.

## Iron

Concentrations in soil ranged from 12,200 to 294,000 mg/kg in unsaturated soil, and 10,200 to 285,000 mg/kg in saturated soil; applicable NJDEP and EPA screening criteria for iron range from 24,000 to 100,000 mg/kg (NJDEP, 1999; EPA, 2004). The highest concentrations are found on the Quanta and former Celotex properties within the documented historical footprint of the former acid plant. Lower-level exceedances of iron were detected at shallow and saturated soils at Block 93 North. Concentrations of iron outside the footprint of the former acid plant are the result of the presence of this constituent in fill material or from other regional sources, such as the past presence of railroads.

## Lead

Concentrations of lead above screening criteria in unsaturated soil were observed across the Site at levels ranging from 402 to 38,800 mg/kg; NJDEP screening criteria range from 400 to 600 mg/kg (NJDEP, 1999; Table 4-5). Lead was detected at concentrations above its screening criterion in 18.8 percent of the evaluated soil samples. Lead isoconcentration contours were plotted for unsaturated and saturated soils and are presented in Figures 4-21 and 4-22, respectively. Review of these figures reveals that the highest concentrations of lead in unsaturated soil were found on the northwestern portion of the Quanta property and in the southwestern portion of the former Celotex property, near the former acid plant. Smaller areas with lead concentrations greater than 1,000 mg/kg were observed near the southern boundary of the Quanta property (MW-103A) and in portions of Block 93 North as isolated exceedances in soil samples collected at SB-19 and SB-28.

Concentrations of lead above screening criteria in saturated soil were observed at levels ranging from 404 to 12,200 mg/kg, primarily on the former Celotex property and on the northern portion of the Quanta property. Elevated lead concentrations also were identified at the former Lever Brothers property as isolated exceedances at borings GZA-48, GZA-23, and GZA-94 (as shown in Figure 4-22) and at SB-28 at Block 93 North.

Elevated lead concentrations in the northwest corner of the Quanta property and the southwestern portion of the former Celotex property (within the documented historical footprint of the former acid plant) of up to 38,800 mg/kg are typically a minimum of one

order of magnitude higher than other locations outside this area and are often described as reddish-purple in color. High concentrations of lead in the southwestern corner of the former Celotex property are at similar elevations as those that are seen in shallower soils in adjacent portions of the Quanta property. Significant filling (as much as 15 feet) during redevelopment of the former Celotex property has caused these impacts to be at much greater depths just a short distance to the north of the elevated concentrations of lead shown in Figure 4-21. Elevated concentrations of lead were removed during hot-spot excavations prior to the construction of the City Place development at the former Celotex property as part of remedial actions approved by NJDEP. Excavation activities involved the removal of soil from in and around borings C-4, 45, 46, 47, 48, 50, 77, 79, 98 and T-5 (Raviv, 2002). Because these impacts have been removed, they are not included in soil isoconcentration contouring of lead in unsaturated soils (Figure 4-21) and saturated soils (Figure 4-22).

Concentrations of lead outside the documented historical footprint of the former acid plant range between 0.01 and 12,200 mg/kg and are likely the result of the presence of this constituent in fill. This source distinction is made based on visual and documented mineralogical differences between slag-, cinder-, and ash-containing fill found outside the mapped historical footprint of the former acid plant and the reddish-purple-impacted soils found within the mapped historical plant footprint, as discussed in detail in Appendix N.

### **Mercury**

Concentrations of mercury in soil ranged from 0.2 to 69.2 mg/kg in unsaturated soil, and 0.2 to 316 mg/kg in saturated soil; screening criteria range from 14 to 310 mg/kg (NJDEP, 1999; EPA, 2004). The highest concentrations were in historical soil samples collected at the former Celotex property and are not related to impacts associated with the Site. Lower-level exceedances of mercury in soil at the Quanta property (up to 69.2 mg/kg) are within the documented footprint of the former acid plant property along its northwestern boundary.

### **Nickel**

Concentrations of nickel in exceedance of the lowest screening criterion in unsaturated soil were detected only at the former Lustrelon property (one location) at a concentration of 1,900 mg/kg. Exceedances in saturated soil ranged from 303 to 661 mg/kg. Screening criteria range from 250 to 20,000 mg/kg (NJDEP, 1999; EPA, 2004). Nickel was detected above the lowest soil criterion in two historical soil samples collected north of the former Celotex property and in samples from GZA-45 at the former Lever Brothers property (shown in Figures 4-19 and 4-20); however, these detections do not appear to be Site-related.

### **Selenium**

Concentrations in unsaturated soil were detected at one location in exceedance of the lowest screening criterion at a concentration of 302 mg/kg in unsaturated soil. Exceedances in saturated soil ranged from 88.3 to 168 mg/kg. Screening criteria range from 63 to 5,100 mg/kg (NJDEP, 1999; EPA, 2004). The highest concentrations are found in the northern portion of the Quanta property and on the southwestern portion of the former Celotex property within the documented footprint of the former acid plant. Selenium concentrations in soil do not exceed the lowest soil criterion outside the documented footprint of former acid plant operations.

## Thallium

Concentrations of thallium in soil ranged from 4.3 to 36.2 mg/kg in unsaturated soil, and 2.27 to 84.2 mg/kg in saturated soil; screening criteria range from 2 to 68 mg/kg (NJDEP, 1999; EPA, 2004). The highest concentrations are found in the northern portion of the Quanta property and on the southwestern portion of the former Celotex property within the mapped historical footprint of the former acid plant. Sporadic lower-level exceedances of soil criteria have also been observed at a location on Block 93 North (SB-13), across River Road (SB-15), and on the former Lever Brothers property (Figures 4-19 and 4-20).

## Vanadium

Concentrations of vanadium in soil range from 82.2 to 106 mg/kg in unsaturated soil, and 85.2 to 155 mg/kg in saturated soil; screening criteria range from 78 to 7,100 mg/kg (NJDEP, 1999; EPA, 2004). The highest concentrations were in historical soil samples collected at the former Celotex property and are not believed to be related to impacts associated with the Site. An additional exceedance of screening criteria was detected in shallow soil at the Quanta property (TL16-06) within the documented former footprint of the acid plant. One exceedance of screening criteria was detected in a historical shallow soil sample (QR-03) collected at Block 93 North (Figures 4-19 and 4-20).

## Zinc

Concentrations of zinc in soil ranged from 1,940 to 3,820 mg/kg in unsaturated soil, and 1,650 to 19,200 mg/kg in saturated soil; screening criteria range from 1,500 to 100,000 mg/kg (NJDEP, 1999; EPA, 2004). The highest concentrations are found in the northern portion of the Quanta property and on the southwestern portion of the former Celotex property within the documented historical footprint of the former acid plant. Zinc does not exceed the lowest soil criterion outside areas associated with the former acid plant operations.

### 4.3.5 Pesticides

Figure 4-25 presents the highest detected concentration of each pesticide exceeding the applicable soil screening criteria for 0 to 4 feet bgs for each soil sampling location evaluated as part of the RI. Pesticides were detected at 90 locations, primarily in saturated soils at the former Lever Brothers property. The majority of these detections were below the lowest applicable soil criteria for the detected compounds. Of the five detections of pesticides on the Quanta property, one was above the lowest applicable screening criterion. Heptachlor was detected at SB-112A at a concentration of 0.35 mg/kg at 1.8 to 2 feet bgs, exceeding its lowest applicable screening criterion of 0.11 mg/kg (EPA Region 9 Residential PRG). No detections of pesticides were above applicable screening criteria on any of the other five properties. Pesticides were not detected in soil greater than 4 feet bgs above the lowest applicable screening criteria.

These data are consistent with the fact that no known historical operations at the Quanta property were associated with pesticides. The presence of low levels of these constituents in soil is likely the result of periodic use during maintenance activities associated with each of the five properties.

### 4.3.6 Polychlorinated Biphenyls

Figures 4-25 and 4-26, respectively, present the highest detected concentration of each PCB Aroclor exceeding the applicable soil screening criteria for 0 to 4 feet bgs and for 4 feet and below for each soil sampling location evaluated as part of the RI. PCB Aroclors detected in soil samples above their applicable soil-screening criteria include Aroclor-1242, 1248, 1254, and 1260. Only Aroclors 1254 and 1260 were detected in more than 5 percent of collected samples, at 21.1 and 13.7 percent, respectively (Table 4-6).

The horizontal extent of total PCBs (sum of all individual Aroclors detected) for samples in unsaturated and saturated soils is depicted in Figures 4-27 and 4-28, respectively. PCBs above the EPA Region 9 Residential PRG of 0.22 mg/kg are located in discrete areas on each of the properties, primarily in unsaturated soil. The three main areas of total PCB concentrations above the lowest screening criterion are as follows:

- Western-central portion of the Quanta property, including a small section of the south-central portion of the former Celotex property extending to the west onto the eastern portion of Block 93, Lot 3
- Eastern to central portion of the former Celotex property extending south along the eastern portion of the Quanta property
- A small section of the south-central Quanta property extending south through the central portions of the 115 River Road and the former Lever Brothers properties

The only area of PCB concentrations detected in saturated soils above the applicable criterion that spanned more than a single sample location was on the former Celotex property near TL 18.5-0.5 and SB-T28. With the exception of the sample collected between 15 and 16.5 feet bgs at TL 18.5-0.5, which indicated an Aroclor 1254 concentration of 46.4 mg/kg. A correlation between the occurrence of NAPL and elevated concentrations of PCBs does not appear to exist.

PCBs were detected in the deep sand unit in one of the three soil samples collected from below the silty clay confining layer. Specifically, Aroclor 1260 was detected at a concentration of 16 mg/kg at a depth of 47.0 to 47.5 feet bgs in SB-101DS. Subsequent confirmatory soil samples collected at TL15-10.75 at depths of 40.5 to 41.5 feet and 47 to 47.5 feet, located immediately adjacent to SB-101DS, did not contain detectable concentrations of PCB Aroclors, confirming that the exceedance of Aroclor 1260 at SB-101DS is not representative of the deep sand conditions in this area.

## 4.4 Groundwater

### 4.4.1 Polycyclic Aromatic Hydrocarbons

Figure 4-29 presents the concentrations of PAHs exceeding applicable groundwater screening criteria for each groundwater sampling location evaluated as part of the RI. The 16

PAHs detected in shallow overburden groundwater samples in exceedance of the lowest applicable criteria are as follows:<sup>15</sup>

- 2-Methylnaphthalene
- Acenaphthene
- Acenaphthylene
- Benzo(a)anthracene
- Benzo(a)pyrene
- Benzo(b)fluoranthene
- Benzo(g,h,i)perylene
- Benzo(k)fluoranthene
- Dibenzo(a,h)anthracene
- Dibenzo(a,h)anthracene
- Fluoranthene
- Fluorene
- Indeno(1,2,3-cd)pyrene
- Naphthalene
- Phenanthrene
- Pyrene

The PAH detected over the largest area was naphthalene, which was detected above the Region 9 Tap Water PRG in 62 percent of groundwater samples collected. Two PAHs (naphthalene and benzo(a)anthracene) were detected in deep sand unit groundwater samples in exceedance of the lowest applicable screening criteria, in groundwater samples collected from monitoring wells MW-103DS and MW-116DS.

To illustrate the distribution of PAHs found in shallow overburden groundwater at the Site, isoconcentration contours of both benzo(a)pyrene and naphthalene are plotted in Figures 4-30 and 4-31, respectively. These constituents were selected as representative of the distribution of PAHs in groundwater since they represent the heavy- and light-end PAHs, respectively, encountered at OU1. As the most mobile of the PAHs due to its solubility (the majority of PAHs being insoluble in water), naphthalene is the PAH most likely to be found in groundwater at the Site, as well as hydraulically downgradient of the Site. Benzo(a)pyrene, like most PAHs, is considered insoluble in water. As would be anticipated based on their differences in solubility, benzo(a)pyrene and naphthalene isoconcentration contours depicted in Figures 4-30 and 4-31, respectively, illustrate naphthalene extends farther downgradient from known areas of NAPL than the extent of benzo(a)pyrene. In general, naphthalene in groundwater covers an area similar in shape and slightly greater than the portion of the Site at which evidence of NAPL has been identified (depicted in Figure 4-4). The extent of dissolved-phase benzo(a)pyrene is limited to within the total lateral extent of NAPL identified either in the monitoring wells or in soils proximal to monitoring wells. Concentrations of both benzo(a)pyrene and naphthalene were detected in groundwater near their effective solubility ranges at monitoring wells with measurable thicknesses of NAPL.

Beyond the areas where Site-related NAPL occurs, offsite sources have been identified at the former Lever Brothers property where Site-related dissolved-phase naphthalene in groundwater has extended south in the direction of groundwater flow, approximately 90 feet from the leading edge of the extent of NAPL (between MW-115A and MW-32) (shown in Figure 4-4). Review of the distribution and concentrations of PAHs in soils and groundwater, and groundwater flow characteristics for this area, detailed in Section 3.3, suggests that additional dissolved-phase impacts of naphthalene from the southwest are converging with this leading edge of the Site-related naphthalene in groundwater. These impacts originate

<sup>15</sup> Each of these constituents was detected in at least 10 percent of groundwater samples in exceedance of the lowest applicable criteria except for acenaphthene, acenaphthylene, benzo(g,h,i)perylene, chrysene, fluoranthene, and fluorene, for which less than 10 percent of samples were in exceedance of lowest applicable criteria.



from separate sources related to AOCs on the former Lever Brothers property (such as the P/A material documented for this property, described in Section 4.1.5).

Wells within and adjacent to the northern P/A material at the former Lever Brothers property were sampled as part of the RI. Results of this sampling indicated the presence of PAHs in groundwater above their applicable criteria at monitoring wells MW-32 and MW-36 near the central portion of the former Lever Brothers property. Monitoring well MW-36, where the highest PAH concentrations in groundwater were observed, is not downgradient of the Site-related impacts observed at monitoring wells MW-107, MW-122, and MW-115B. These sources and their associated impacts are being addressed separately pursuant to the NJDEP ISRA program by the current owners of the property.

Dissolved-phase impacts from Site-related NAPL and the sources related to historical operations at the former Lever Brothers property likely are commingling in the central portion of the former Lever Brothers property hydraulically downgradient of monitoring wells MW-36 and MW-115 (shown in Figures 4-29, 4-30, and 4-31). This is a result of an area of localized groundwater convergence that appears to be controlled by a stormwater line in the area, as described in Section 3.3.1.

The other area where concentrations of PAHs in groundwater extend beyond the footprint of the extent of Site-related NAPL is within the southwestern portion of the former Celotex property. Specifically, monitoring wells MW-A-1 and MW-A-2 (Figure 4-29) that were sampled as part of the RI had concentrations of naphthalene up to 1,500 and 1,200 µg/L, respectively. Coal tar and NAPL impacts have not been found to extend as far north as these wells (Figure 4-4). These impacts might be the result of historical fuel oil releases from a former fuel oil tank associated with the former acid plant operations that was historically located directly adjacent to the location of these wells (shown in Figure 4-4). These impacts also could be the result of releases from ASTs that were once located hydraulically upgradient of these monitoring wells to the west within the current footprint of River Road.

With the exception of naphthalene and benzo(a)anthracene, PAHs were not detected above applicable screening criteria in any groundwater samples collected from monitoring wells screened in the deep sand unit, indicating that dissolved-phase impacts for most PAHs are confined to the shallow fill and native sand deposits above the silty-clay aquitard. Naphthalene was detected in samples collected from deep sand monitoring wells MW-103DS and MW-116DS above the EPA Region 9 Tap Water PRG of 6.2 µg/L at concentrations up to 10 and 200 µg/L, respectively. Concentrations of this constituent were considerably lower than those seen in samples collected from the collocated shallow wells and did not exceed the New Jersey GWQS of 300 µg/L in any samples collected from deep sand monitoring wells. Benzo(a)anthracene was detected at a concentration of 0.243 µg/L in one of the four groundwater samples collected from monitoring well MW-116DS during the RI (Figure 1-3). In this area, the thickness of the silty-clay aquitard is reduced significantly, and the deep sand unit is encountered at a much shallower elevation near the wooden bulkhead adjacent to the Hudson River where MW-116DS is located, compared to other locations throughout the Site (see geologic cross-section A-A' in Figure 3-2).

Deep sand impacts at MW-116DS associated with Site-related constituents are localized to this area and are the result of the migration of lower levels of these constituents in groundwater from the overlying shallow unit and the fact that the well screen at this

location is partially screened within the silty clay at a depth of only several feet below the overlying shallow groundwater. Due to the proximity of groundwater impacts in the overlying shallow fill and native sands, the underlying deep sand groundwater could be impacted in this area.

#### 4.4.2 Semivolatile Organic Compounds

The 11 SVOCs that were detected in groundwater samples in exceedance of the lowest applicable criteria are as follows.

- 1,1'-Biphenyl
- 2,4-Dimethylphenol
- 2-Methylphenol
- 3&4-Methylphenol
- 4-Methylphenol
- Bis(2-ethylhexyl)phthalate
- Caprolactam
- Carbazole
- Dibenzofuran
- Nitrobenzene
- Phenol

Figure 4-32 presents the highest detected concentration of each SVOC exceeding the lowest applicable screening criterion for each groundwater sampling location evaluated as part of the RI. Of these constituents, dibenzofuran and carbazole were detected most frequently above the most conservative screening criteria, the EPA Region 9 Tap Water PRGs, appearing in 49.1 percent and 68.4 percent of samples, respectively. Each of the remaining SVOCs exceeded the lowest applicable criteria in at least 5 percent of the groundwater samples collected with the exception of 1,1'-biphenyl, bis(2-ethylhexyl)phthalate, caprolactam, nitrobenzene, and phenol, which exceeded the lowest applicable criteria in the range of 1.8 to 3.5 percent of samples collected during the RI.

To illustrate the distribution of dissolved-phase SVOCs at the Site, isoconcentration contours for dibenzofuran concentrations during the most comprehensive groundwater sampling event (August 2006) are provided in Figure 4-33. Dibenzofuran was selected as representative of the extent of non-PAH SVOC impacts in groundwater because it is slightly soluble (compared to carbazole, which is considered insoluble) and was detected in groundwater frequently above its lowest applicable groundwater criterion (EPA Region 9 Tap Water PRG of 12 µg/L). The solubility of dibenzofuran in water is 3.1 mg/L, slightly more soluble than the majority of PAHs and an order of magnitude less soluble than naphthalene, which is 31 mg/L soluble.

As might be expected, based on relative solubility, the extent of dibenzofuran in groundwater as illustrated in Figure 4-33 is a similar shape but has not migrated as far as naphthalene. However, unlike naphthalene, which was detected with the highest concentrations near the MW-102 cluster, dibenzofuran was detected at the highest concentration near the MW-116 well cluster. The extent of carbazole in groundwater with concentrations exceeding its Region 9 Tap Water PRG is located within the footprint of dibenzofuran exceedances in groundwater (shown in Figure 4-33).

Additional sources of PAHs in groundwater in the central portion of the former Lever Brothers property discussed above appear to be sources of dibenzofuran in groundwater at concentrations above the lowest applicable screening criterion. Dibenzofuran in groundwater samples collected from monitoring well MW-36 is a result of the sources associated with the former Lever Brothers property and is not related to the Site. The current owners of the

property are separately addressing these sources and their associated impacts under the NJDEP ISRA.

No non-PAH SVOCs in groundwater were detected above their applicable criteria in samples collected from deep sand unit deposits, indicating that dissolved-phase SVOC impacts are confined to the shallow fill and native sand deposits above the silty-clay confining unit.

#### 4.4.3 Volatile Organic Compounds

The 19 VOCs that were detected in groundwater samples above their applicable screening criteria during RI groundwater sampling are as follows.

- 1,1-Dichloroethane (1,1-DCA)
- 1,1-Dichloroethene (1,1-DCE)
- 1,2,4-Trichlorobenzene (1,2,4-TCB)
- 1,2-Dichloroethane (1,2-DCA)
- 1,2-Dichloropropane (1,2-DCP)
- 1,4-Dichlorobenzene (1,4-DCB)
- Benzene
- Chloroethane
- Chloroform
- Ethylbenzene
- Methylcyclohexane
- o-Xylene
- Styrene
- PCE
- Toluene
- TCE
- Vinyl chloride
- Xylenes (m & p)
- Total xylenes

Figure 4-34 presents the highest detected concentration of each VOC exceeding the applicable groundwater screening criterion for each groundwater sampling location evaluated as part of the RI. Only BTEX compounds and TCE were detected in groundwater at concentrations greater than their applicable criterion in more than 10 percent of groundwater samples. The most frequently detected VOC in groundwater was benzene, which was detected in 71.9 percent of groundwater samples.

#### Aromatic VOCs

Isoconcentration contours for benzene in shallow groundwater during the most comprehensive groundwater sampling event (August 2006) are provided in Figure 4-35. The distribution of benzene in groundwater, like naphthalene, is consistent with the known distribution of Site-related NAPL. With a greater solubility in groundwater, benzene exceedances in groundwater extend farther hydraulically downgradient of NAPL than naphthalene. Benzene concentrations above the EPA Region 9 PRG (0.35 µg/L) extend onto the former Lever Brothers property to the east almost to the Hudson River near the MW-106 monitoring well series. Benzene in groundwater exceeding criteria extends farther north onto the former Celotex property to the edge of the existing elevated parking structure. This is based on elevated concentrations of benzene detected in samples collected from MW-C that have ranged between 290 and 456 µg/L across the RI sampling events. These concentrations are likely the result of a thin layer of NAPL between 18 and 20 feet bgs near this monitoring well. Samples collected from monitoring wells located outside this area of NAPL on the former Celotex property did not contain constituents in groundwater above screening criteria (MW-F), or contained significantly lower concentrations (MW-B) than those observed at MW-C (shown in Figure 4-35). These isoconcentration contours and the

distribution of benzene closely mirror the interpreted shallow groundwater flow paths as developed from groundwater elevation surveys (shown in Figure 3-5).

Sources of SVOCs (including PAHs) in groundwater in the central portion of the former Lever Brothers property appear to be the same as the source of benzene in groundwater here. Concentrations of benzene in groundwater samples collected from monitoring wells MW-4, MW-32 and MW-36 (shown in Figure 4-35) are a result of sources associated with the former Lever Brothers and are not related to the Site. The current owners of the property are separately addressing these sources and their associated impacts under the NJDEP ISRA program.

Xylene was the second most frequently detected nonchlorinated VOC in shallow groundwater, detected above the lowest applicable criterion at 33.3 percent of sampled monitoring wells. The extent of xylene, as well as each of the other nonchlorinated VOCs, in groundwater above screening criteria is within the footprint of Site-related dissolved-phase benzene.

With the exception of benzene concentrations of between 0.4 and 10 µg/L in groundwater samples collected from monitoring well MW-116DS, aromatic VOCs were not detected above their applicable criteria in groundwater samples collected from monitoring wells screened in deep sand unit deposits below the confining unit. The thickness of the silty-clay confining unit is significantly reduced, and the deep sand unit is encountered at a much shallower elevation near the wooden bulkhead adjacent to the Hudson River where MW-116DS is located, compared to other locations throughout the Site (see geologic cross-section A-A' in Figure 3-2). As mentioned in Section 4.4.1, due to the proximity of groundwater impacts in the overlying shallow fill and native sands, the underlying deep sand groundwater appears to be impacted in this area. Despite this localized exceedance of screening criteria, the extent of nonchlorinated VOCs in groundwater is limited generally to the shallow unconfined fill and sand deposits. The distribution of the deep sand in the shoreline areas and the extent of coal tar impacts observed within and above these deposits will be addressed as part of the SRI.

### **Chlorinated VOCs**

The chlorinated VOCs that were detected in groundwater samples collected during the RI were: 1,2-DCA, 1,1-DCE, 1,2,4-TCB, 1,2-DCP, 1,4-DCB, chloroethane, chloroform, PCE, TCE, and vinyl chloride. Each of these constituents was detected in one or more location at concentrations exceeding the lowest applicable screening criterion. Only TCE was detected above its lowest applicable screening criterion in over 10 percent of the samples collected during the RI (appearing in 17.5 percent of samples). No chlorinated hydrocarbon NAPL has been observed at the Site, nor do any of chlorinated organic compound concentrations observed in groundwater at the Site approach the EPA "Rule of Thumb" of 1 percent of the effective pure phase solubility for any these compounds, which would suggest the presence of chlorinated solvent NAPL (EPA, 1992a).

Low-level concentrations of chlorinated VOCs were detected in groundwater samples collected from wells screened within the shallow fill and native sand at each of the properties. The constituent with the highest concentration of the chlorinated VOCs detected during the RI was 1,2-DCA, which was detected at levels between 51.8 and 120 µg/L in groundwater samples collected from monitoring well MW-B at the former Celotex property

during 2006 sampling events, as summarized in Table 4-8. Detections of all other chlorinated VOCs exceeding groundwater criteria in shallow groundwater ranged between 0.1 and 6.2 µg/L. The presence of chlorinated solvents in shallow groundwater does not correlate with the presence of NAPL (samples of which do not contain chlorinated solvents) or any dissolved-phase impacts associated with the NAPL (i.e., naphthalene and benzene). The distribution of these low-level detections in groundwater and the absence of any significant concentrations of these constituents in soil indicate that the presence of chlorinated solvents is not the result of the presence of a localized source of this material.

Groundwater samples collected from monitoring wells screened within the deep sand deposits contained 1,1-DCE, 1,2-DCA, chloroform, PCE, TCE, and vinyl chloride at concentrations above the lowest applicable groundwater criteria. In general, concentrations of chlorinated VOCs were higher in the groundwater samples collected from the deep sand unit compared to the shallow groundwater samples. The constituent with the highest concentration in the deep sand was TCE, detected in samples collected from the most hydraulically upgradient deep sand monitoring well MW-101DS at levels between 380 and 460 µg/L during 2006 sampling events (Table 4-8). The concentration of this constituent in samples collected from the collocated shallow groundwater monitoring well (MW-101A) was 0.2 µg/L. Concentrations of this constituent decline in the hydraulically downgradient direction where they were found in groundwater samples up to 142 µg/L and 14.5 µg/L in monitoring wells MW-103DS and MW-116DS, respectively. Lower concentrations of TCE were detected in hydraulically downgradient deep sand monitoring well MW-107DS (between 0.1 and 0.2 µg/L). Additional chlorinated VOCs in deep sand monitoring wells are found at significantly lower concentrations and appear to be the anaerobic degradation daughter products associated with the natural attenuation of TCE.

Multiple lines of evidence indicate that the source of chlorinated solvent impacts in the deep sand groundwater is not the result of a release, or releases related to Site-specific historical operations. First, as noted in Section 3, shallow groundwater within the fill and native sand is not hydraulically connected to the groundwater of the underlying deep sand unit due to the contiguous presence of the silty-clay aquitard. This is evidenced by consistently greater hydraulic heads measured in the deep sand unit compared to those measured above the silty clay in the shallow groundwater unit. Secondly, concentrations of TCE and other chlorinated solvents in shallow soil throughout the Site including soils near monitoring well MW-101DS do not suggest that a source of these impacts exists at the Site. Finally, the fact that this constituent is present at much higher concentrations in groundwater within the deep sand compared to collocated samples collected from the shallow groundwater, as well as the fact that the highest concentrations have consistently been detected in groundwater at the most hydraulically upgradient well, suggest that the source of these deep sand impacts is hydraulically upgradient of the Site and is the source discharged directly to groundwater hydraulically connected to the deep sand (e.g., above the Palisades Sill).

#### **4.4.4 Inorganic Constituents**

The inorganic constituents detected in shallow groundwater at the Site at levels above the lowest screening are summarized below and then discussed in more detail. Figure 4-36 presents the highest detected concentration of each inorganic constituent exceeding the applicable groundwater screening criterion for each groundwater sampling location

evaluated as part of the RI. The lowest screening criterion for each of these constituents and the maximum detection in groundwater are presented in Table 4-6.

### **Ammonia**

Ammonia was detected in groundwater above its lowest screening criterion, at concentrations ranging from 3,100 µg/L to 24,100 µg/L. Isoconcentration contours for ammonia in groundwater collected during the most comprehensive groundwater sampling event (August 2006) and supplemented with data from additional wells collected in October 2006 as part of SI activities are provided in Figure 4-39a.

The highest concentration of ammonia was detected in groundwater samples collected from monitoring well MW-112B on the northwestern portion of the Quanta property. Review of the ammonia isoconcentration contours presented in Figure 4-39a revealed that the area with ammonia concentrations above the lowest screening criterion (based on data collected in August and October 2006) covers the majority of the Site, with the exception of MW-109A.

### **Arsenic**

Concentrations of dissolved arsenic in monitoring wells are largely a function of pH, redox conditions, and partitioning coefficients at the Site. Arsenic was detected in groundwater above its lowest screening criterion at concentrations ranging from 0.86 µg/L to 1,590 mg/L. Isoconcentration contours for arsenic in groundwater collected during the most comprehensive groundwater sampling event (August 2006) and supplemented with data from additional samples (collected in October 2006 and June 2007) are provided in Figure 4-38.

The highest concentrations of arsenic were detected in groundwater samples collected from monitoring well MW-N-1 on the southwestern portion of the former Celotex property (shown in Figure 4-36), ranging from 27,900 to 126,000 µg/L during 2006 sampling events. Other areas of elevated arsenic concentrations are present near the MW-111 well series, near the MW-107 series, and near MW-122. Slightly lower concentrations, still well above the applicable lowest groundwater criterion, are present in the western portion of Quanta property (1,570 to 28,800 µg/L), adjacent to the Hudson River at the former Celotex property near MW-C (987 µg/L), and farther south along the shoreline at the former Lever Brothers property near MW-109 (1,860 µg/L). Similar to the distribution of organics such as naphthalene and benzene, additional elevated concentrations of arsenic appear to be present to the south of the groundwater convergence in the area of the P/A material associated with the former Lever Brothers property.

Although arsenic is not a constituent of Site-related NAPL or other non-Site-related sources of organic constituents such as the P/A area in the central portion of the former Lever Brothers property, the distribution of arsenic in groundwater is very similar to that of dissolved-phase organics such as naphthalene and benzene. The presence of arsenic in groundwater is a function of the relationship between oxidation reduction (redox), which is measured by oxidation-reduction potential (ORP), and pH conditions in groundwater. Variations in redox and pH influence the valence state of certain constituents, such as arsenic, and their concentrations and, therefore, their exceedances of regulatory criteria in groundwater samples (Welch et al., 2000). Reduced groundwater conditions are created in

the presence of significant sources of organic material (such as NAPL and associated dissolved-phase constituents) because these sources are degraded through natural microbial processes. To illustrate this relationship, Figure 4-39b depicts the location of reddish-purple soil, coal tar, and arsenic in groundwater. At this location, the valence state of arsenic is reduced, and it becomes the species of arsenic known as arsenite (As III). Speciation data, included in Appendix F, for arsenic in groundwater samples that were collected at select monitoring wells during SI activities support the fact that the species of arsenic that is seen throughout OU1 in elevated concentrations is the reduced arsenite species. Moreover, during sampling, groundwater samples were acidified (as required by the analytical method), further elevating concentrations of arsenic in the groundwater samples due to the presence of arsenic-rich colloidal iron oxyhydroxides.<sup>16</sup> These data are summarized in Table 4-10.

Furthermore, an evaluation of microbial activity within groundwater at the Site was performed through the analysis of these same groundwater samples for total Kjeldahl nitrogen (TKN) and ammonia. The combination of ammonia and organic forms of nitrogen comprise TKN. Organic nitrogen is generated by microbial enzymatic processes and therefore reflects the relative amount of microbial activity in the groundwater zone. This organic form of nitrogen is calculated by subtracting the ammonia nitrogen from the TKN. These data are summarized in Table 4-10 and suggest that a significant portion of the TKN (around 60 percent) in groundwater throughout the majority of the Site is organic nitrogen. These data further support the conclusion that microbial activity is an important factor for constituents in groundwater. When microbial activity is high in areas of elevated arsenic concentrations in groundwater, the breakdown of arsenic compounds through microbial processes into methylated organic species (typically more toxic than arsenic in its inorganic form) is a concern. To evaluate the potential presence of methylated species of arsenic, groundwater samples collected at select wells for arsenic speciation during the SI were analyzed also for the methylated species of arsenic, MMA and DMA. The results of these analyses are summarized in Table 4-10 and indicate that only very low levels of the methylated species of arsenic are present in groundwater at the Site. Specifically, DMA was detected in only two samples at concentrations 0.523 and 0.753  $\mu\text{g/L}$  in samples collected from monitoring wells MW-B and MW-113B, respectively. MMA was detected more frequently in groundwater samples between 0.066 and 0.938  $\mu\text{g/L}$ .

Soil data, visual observations, and documented mineralogical differences suggest that the two sources of arsenic exist within soils throughout Site – the reddish-purple soils in the documented historical footprint of the former acid plant and the fill material across the rest of the Site. Groundwater pH and redox (e.g., ORP) conditions largely control the elevated arsenic concentrations and exceedances of regulatory criteria of arsenic in groundwater throughout the Site. The effects of groundwater geochemistry on arsenic are discussed in greater detail as part of the fate and transport discussion for arsenic in Section 5.4.5.

<sup>16</sup> Freshly precipitated iron oxyhydroxide is a colloid-sized particle with a very large surface area and strongly sorbs arsenic and other metals and usually metalloids (such as arsenic and selenium), enhancing their respective concentrations that will pass through a 0.45- $\mu\text{m}$  filter. With time, the iron oxyhydroxide colloids flocculate and can become larger particles that are filtered out of the dissolved groundwater sample with a 0.45- $\mu\text{m}$  filter. There is always some proportion that is not filtered and increases the quantity metals and metalloids in the dissolved groundwater analysis. Upon acidification of the groundwater samples for method preservation purposes, arsenic and other metals are released to the sampled water when the iron oxyhydroxides are dissolved, further biasing high the arsenic concentrations.

## Lead

Lead was detected in groundwater above its lowest criterion at concentrations ranging from 5.1 µg/L to 4,100 µg/L. Isoconcentration contours for lead in groundwater during the most comprehensive groundwater sampling event (August 2006) are provided in Figure 4-37.

The distribution of lead in groundwater indicates that the majority of groundwater where lead exceeds its lowest criterion is located on the former Celotex property and the northwestern portion of the Quanta property. These impacts coincide with the mapped historical footprint of former acid plant operations in this area. The highest lead concentrations measured in groundwater were detected in samples collected from monitoring well MW-A-2 and ranged between 590 and 4,100 µg/L during 2006 sampling events. The location of this well correlates with the approximate location of the highest concentrations of lead in unsaturated and saturated soils. In addition, the pH of groundwater measured in monitoring well MW-A-1 during the RI was between 4.6 and 5.92. These low pH values indicate slightly acidic groundwater, which can promote the dissolution of lead (Swayze et al., 1996). Lower concentrations of lead extend to the south from MW-A-1 and have been observed in one sample collected from monitoring well MW-112A at 50.2 µg/L. Along the bulkhead at the Quanta property, farther south at the MW-106 well cluster, and as far south as MW-109, lower concentrations of lead (between 5.6 and 19.5 µg/L) were detected during the RI. Exceedances of the lowest screening criterion of lead also have been detected in groundwater at the MW-111 well series and at MW-108. Detections of lead were observed in deep sand groundwater above the lowest criterion in samples collected from MW-107DS between 10 and 20.2 µg/L. All other lead detected in deep sand groundwater samples was at concentrations below 1.5 µg/L, well below the lowest applicable screening criterion (NJ GWQS) of 5 µg/L.

Beyond the impacts observed in the northwest corner of the Quanta property and throughout the former Celotex property, lead concentrations in groundwater are likely the result of the presence of this constituent in the native sands and saturated fill deposits in this area. Along the shoreline of the Hudson River, results above the lowest applicable screening criterion were located in monitoring wells along the bulkhead at the Quanta property and farther south at monitoring wells MW-106 and MW-119.

## Iron

Iron was detected in groundwater above its lowest criterion (GWQS of 300 µg/L) at concentrations ranging from 650 µg/L to 401,000 µg/L. The majority of iron in groundwater exceeding this criterion is located on the former Celotex property. The highest concentration of iron was detected at MW-107A on the former Lever Brothers property. Concentrations of iron above 100,000 µg/L were detected in samples from at least one well on each property included in the Site, with the exception of the 115 River Road property. In almost all cases where iron concentrations are elevated, groundwater conditions are acidic (pH values between 4.5 at MW-107 and 6.6 at MW-111B). These data indicate that the speciation of iron, like that of arsenic, is a function of pH/redox conditions. Unless higher redox potentials are present (i.e., ORP > 300+ mV), which is generally not the case in the areas where increased concentrations of organics (e.g., coal tar) are present, iron will remain in its reduced and dissolved state (Fe<sup>2+</sup>) at conditions of pH below approximately 6.5. The lower the pH of the



groundwater, the higher the redox potentials would have to be in groundwater in order to remove iron from solution.

Similar to arsenic, soil data and observations suggest that two sources of iron exist within soils throughout Site—the reddish-purple soils in the mapped historical footprint of the former acid plant and the fill material across the rest of the Site. Groundwater pH and redox conditions largely control iron concentrations and, therefore, exceedances of regulatory criteria, throughout the Site. Due to the affinity of arsenic to adsorb to iron hydroxide minerals, the valence state and ability of iron to mineralize is a dominant factor in the distribution and mobility of arsenic for most groundwater systems. The effect of groundwater geochemistry on iron and arsenic will be discussed in greater detail as part of the fate and transport discussion for iron in Section 5.4.5.

#### **4.4.5 Pesticides**

Five pesticides (4,4'-dichlorodiphenyldichloroethane [DDD], 4,4'-dichlorodiphenyldichloroethylene [DDE], aldrin, alpha-benzene hexachloride [BHC], and heptachlor) were detected at the Site in shallow groundwater above screening criteria. Alpha-BHC was the pesticide detected above its lowest applicable criterion at more than one location (MW-112B and MW-117B). Figure 4-40 presents the highest detected concentration of each pesticide and/or PCB Aroclor exceeding the applicable groundwater screening criterion in samples evaluated as part of the RI. Samples from three monitoring wells, each located on the Quanta property, contained pesticide concentrations above the applicable lowest screening criterion: MW-103, MW-112B, and MW-117B.

The degree to which each of the detected pesticide concentrations exceeded the applicable criterion were small compared to other COIs in groundwater. Similar to pesticides in soil, exceedances of the lowest criteria for pesticides in groundwater appear localized and are not contiguous among locations where they were observed. At each sampling location where an exceedance was identified, the pesticide concentrations in the groundwater samples collected from the collocated well did not exceed applicable criteria for pesticides. Furthermore, pesticides were not detected in the confined deep sand unit. Based on these observations, the concentrations of pesticides detected likely are a result of limited past use of pesticides at the Site, rather than a result of a source area within the Site boundaries.

#### **4.4.6 Polychlorinated Biphenyls**

One Aroclor at one location (MW-J) was detected in groundwater at a concentration exceeding the applicable screening criterion (shown in Figure 4-40). Aroclor 1260 was detected at MW-J (former Celotex property) at a reported concentration of 6.1 µg/L, which is at or above the solubility limit (Cohen and Mercer, 1993) and, therefore, likely caused by turbidity. Several exceedances for PCBs have been detected in soils on the former Celotex property, likely due to their insolubility; however, PCBs have not been detected in groundwater. Soil data from MW-J was not available for RI evaluations; however, industrial activities have taken place near this location since the late 1800s. PCBs were not detected in groundwater at any other location evaluated during RI activities. PCBs detected in soil at OU1 do not appear to be affecting shallow or deep groundwater.

## 4.5 Preferential Pathways Evaluation

The objective of this assessment was to determine whether subsurface features and their associated bedding material are, or at one time were, a conduit for constituents to migrate from OU1 to either OU2 or neighboring properties.

Numerous subsurface drain, water, and sewer lines surround the Quanta property as part of private and municipal infrastructures supporting the developed properties. In addition, abandoned subsurface features are present within the Quanta property. These features include a discharge from the former oil/water separator, a fire-suppression intake, and other drain and discharge features associated with the former operations. A select number of subsurface utilities were recognized to have the potential to act as preferential pathways for Site-related constituents based on their depth, proximity to known impacts, and alignment relative to the Hudson River.

GeoSyntec investigated potential preferential pathways in 1998 when they performed a geophysical survey and test trenching at the Site. The results of this investigation were summarized in the RSI Report (GeoSyntec, 2000b). The geophysical survey identified an 18-inch pipe that extended east-west in the middle of the Quanta property. GeoSyntec states that this pipe “appears to be the drain from the oil/water separator.” GeoSyntec also states, “a previous investigation (Weston, 1995) indicates a conduit aligned with the oil/water separator drain pipe extending to the river.” GeoSyntec attempted to excavate the 18-inch-diameter pipe but was unable to do so beyond a point approximately 325 feet west of the bulkhead. As a result of the inability to find evidence of the continuation of the 18-inch-diameter pipe GeoSyntec concludes, “...this section of the pipe may have been removed during the last Removal Action [at the Site].”

Also identified during Geosyntec’s investigation were numerous additional localized features that were only several feet in length, indicating the presence of buried metallic objects and reinforced concrete rather than significant linear features. Test trenching was performed primarily on the eastern half of the Quanta property and on a limited area in the southeastern portion of the former Celotex property. Test trenching revealed numerous pipes throughout the Quanta property ranging from 1 to 10 inches in diameter in addition to a 4-inch-diameter pipe on the former Celotex property. The test trenches and pipes identified during the GeoSyntec investigation in 2000 are shown in Figure 2-4. Most pipes were steel, two were terra cotta, and several contained semisolid and viscous NAPL (as noted in Figure 2-4).

According to the *Building 700 Area and South RI – Coal Tar Investigation and V/W-15 Test Pit Excavation/Pipe Removal Excavation Investigation Report* (EWMA, 2003), four pipes including three 8-inch terra-cotta pipes and one 4-inch cast iron pipe were observed and removed from an area along the south-central portion of the former Celotex property as part of remediation and redevelopment activities.

Various sources were consulted to confirm the locations of any additional former and existing subsurface utilities at the Site, including the 1930 and 1968 Sanborn® Fire Insurance Maps, Town of Edgewater engineering plans, the RSI Report (GeoSyntec, 2000b), historical private insurance maps, and a current utility mark-out figure for the former Lever Brother’s

property. A map showing all identified subsurface utilities within the public rights-of-way and at adjacent properties is included as Figure 2-4.

CH2M HILL performed two follow-up activities as part of the preferential pathways assessment. In 2005, a field survey was performed in which observations of utilities at the border of the Site and the Hudson River were documented. In 2007, soil samples were collected from around four pipelines at the Site. The observed utilities and sample locations are shown in Figure 2-4.

Subsurface utilities on and near the Quanta property, which have been observed exiting the various properties to the Hudson River and transect areas where NAPL impacts have been observed, consist of:

- The following out-of-use utilities at the Quanta property
  - A 38-inch-diameter discharge pipe (P1)
  - An 8- to 10-inch-diameter discharge pipe (P2)
  - A former fire-suppression water intake line
  - An unknown small-diameter pipe (P3)
  - Two unknown 8-inch-diameter steel pipes
- A 4-inch-diameter storm drain pipe at the 115 River Road, LLC property (P4)
- A 36-inch-diameter storm drain pipe at the former Lever Brothers property

To better understand if these utilities are acting as a preferential pathway for OU1 impacts to reach the Hudson River, soil samples were collected in February and March 2007 from around the outfalls of four pipes – three on the Quanta property (P1, P2, and P3) and one on the 115 River Road property (P4). The former fire-suppression water intake line was not sampled because it terminates to the east of the bulkhead prior to entering OU1 and therefore cannot act as a pathway from OU1. The two unknown 8-inch-diameter pipes were not sampled because they could not be located in the field. The 2005 field survey indicated that they are located on the Quanta property next to the exposed former timber support piles (observed from a boat in the Hudson River). The 36-inch outfall pipe at the former Lever Brothers property was not sampled because no visual evidence of NAPL at its discharge point has been observed during various field activities in that area or during the field utility survey. This drain is from the northernmost pipeline on the former Lever Brothers property and is labeled as a sanitary sewer line on a Langan Engineering and Environmental Services Utility Markout Figure (2003), drawn by Conopco, Inc. d/b/a Unilever Research And Development-Edgewater.

Accutest Laboratories analyzed soil samples for VOCs, SVOCs, and PCBs by using the EPA-approved methods specified in the revised QAPP (CH2M HILL, 2006a). Soil samples from P1, P2, and P3 were analyzed for PAH fingerprinting by META due to the presence of NAPL at these locations. Appendix H presents the preferential pathways soil sample results. Locations of each identified pipe and where samples were collected are illustrated in Figure 2-4.

- **P1:** The approximate location of P1 was identified and an excavation was performed approximately 20 to 30 feet inland. P1 originally was identified during reconnaissance from the bank of the Hudson River as a 36-inch-diameter pipe based on visual observations of the pipe at the bank; however, the pipe located within the excavation

was 8 to 10 inches in diameter and approximately 5 feet bgs. The soil surrounding the pipe was impacted heavily with a viscous black liquid that had an iridescent sheen and a strong odor. A sample was collected from the soil beneath the pipe and submitted for chemical analysis and fingerprinting.

- **P2:** The approximate location of P2 was identified and an excavation was performed approximately 60 to 70 feet inland. The excavation was performed and an 8- to 10-inch-diameter pipe was found approximately 3 feet bgs. P2 originally was identified as a water line based on the field survey conducted in the fall of 2005; however, it was uncertain whether this is the pipe found in the excavation due to the inability to see the identified pipe without a boat. The soil in the excavation beginning about 1 foot bgs was a solid tar. The pipe terminated in the excavation, and it was encrusted in solid tar. A sample was collected from the soil beneath the pipe and submitted for chemical analysis and fingerprinting.
- **P3:** Originally identified as a small-diameter pipe based on visual observations of the pipe underneath the bulkhead. At the approximate location of P3, a small-diameter pipe was found coming out from under the bulkhead into a concrete trench at ground surface. This pipe terminated in the trench and was severely deteriorated. An excavation was performed in search of any other pipes in the area. The pipe found at P3 was approximately 8 to 10 inches in diameter and approximately 4 feet bgs. The soil in the excavation beginning about 1 foot bgs was solid tar. The pipe turned at a 45 degree angle in the excavation, and it was encrusted in solid tar. A sample was collected from the soil beneath the pipe and submitted for chemical analysis and fingerprinting.
- **P4:** Located on the mudflat directly under the east edge of the parking lot of 115 River Road, P4 is underwater at most times and is accessible only at low tide. No material was found around the pipe to be sampled, so the sediment inside of the pipe was sampled and submitted for chemical analysis. No noticeable NAPL or product odors were present at this location. The depth of the sample collected at this location was approximately 3 feet bgs.

Sample results confirm the similarity of samples collected from P2 and P3. These samples had similar concentrations of detected constituents that were, in most cases, at least twice that of those detected in P1 and at least one order of magnitude greater than those in P4.

In general, concentrations of detected SVOCs in P2 and P3 were at least two times those observed in samples from P1 and a minimum of one order of magnitude greater than the sample collected at P4. Three SVOCs detected in P2 and P3 were undetected in P1 and P4 (i.e., 2,4-dimethylphenol, 2-methylnaphthalene, and 3&4-methylphenols).

Seven VOCs were detected in one or more of the samples—benzene, ethylbenzene, isopropylbenzene, o-xylene, toluene, xylenes (m & p), and total xylenes. While detections of ethylbenzene and isopropylbenzene were within the same order of magnitude for P1, P2 and P3, detections of xylenes were two orders of magnitude greater at P1 than at P2 and P3. Detections of toluene were one order of magnitude greater at P2 and P3 than at P1. Benzene was not detected at P2 but was detected at P1, P3, and P4. Detected VOCs were two orders of magnitude less at P4 than at other sample locations. Two of the VOCs detected at P1, P2 and P3 were not detected at P4, isopropylbenzene and toluene.

The PCB Aroclor-1254 was detected in samples from P2 and P4 at concentrations of 4.0 mg/kg (estimated concentration) and 0.16 mg/kg, respectively.

Samples of P1, P2, and P3 were sent to META for PAH fingerprinting analysis. META concluded that P1, P2, and P3 contained similar mixtures of pyrogenic and petrogenic materials with varying degrees of weathering observed.; P2 was the least weathered and P1 the most weathered. P2 and P3 appear to be very similar in composition. The pyrogenic material in the three samples appears to come from the same source and, based on the PAH content, appears to have experienced moderate weathering, or the material is a coal-tar distillation product such as creosote or middle coal tar distillate. The petrogenic material in these samples, which was of a much lower concentration relative to the pyrogenic component, shows less similarity among the three samples. The P1 sample appears to have a low level of highly weathered blended oil present, such as a No. 4 fuel oil.

A summary of the analytical results for samples collected as part of the preferential pathways evaluation is located in Appendix H.

The results of the preferential pathways evaluation may be used to conclude that there are pipes of various sizes and materials of construction present in the subsurface at OU1. However, data collected does not indicate that any of the pipes investigated are currently acting as preferential pathways for the migration of NAPL or other COCs to OU2 or offsite. The presence of NAPL outside the pipes may indicate that they leaked or provided a preferential pathway in the past; however, the presence of NAPL alone is not conclusive evidence that the pipes are leaking or have leaked. NAPL is present in many areas of subsurface soil throughout OU1, regardless of the presence of subsurface features such as pipes.

No evidence of a discharge pipe or drain associated with the oil water separator was observed during any of the field work performed during the RI as it is described and depicted in previous reports (GeoSyntec, 2000b; Weston, 1995). Both preferential pathway investigation excavations P-1 and P-2 were located in the area where the oil-water separator pipeline is depicted in historical figures such as Figure 2-5 of the GeoSyntec (2000b) RSI Report; however, no evidence of the described 18-inch pipe/drain was observed in either of these excavations. Furthermore, no 18-inch or larger-diameter pipe has been observed near the Hudson River shoreline during either aboveground field survey or during the survey performed by boat in the Hudson River.

## 4.6 Vapor Intrusion Evaluations

VOCs in subsurface soils or in groundwater can volatilize, migrate through soil gas, and subsequently be transported into indoor spaces through vapor intrusion, potentially producing inhalation exposure. Inhabited buildings are located to the north and south of the Quanta property, and across River Road on Block 93. Potential sources of constituents for vapor intrusion around the Quanta property include NAPL, dissolved-phase Site-related COIs in groundwater, and Site-related COIs in soil, which are located nearby and in some cases underneath these buildings.

At the request of EPA, a vapor intrusion investigation was conducted at the 115 River Road building complex, located south of the Quanta property. Potential vapor intrusion pathways

also have been evaluated at Building 9 on the former Lever Brothers property (GZA, 2007a), and at 163 Old River Road located on Block 93. The results of these investigations are discussed in the following subsections. The results of each vapor intrusion evaluation are discussed in detail in the technical memoranda provided in Appendix K.

#### **4.6.1 115 River Road Building Complex**

##### **2006 Vapor Intrusion Evaluation**

CH2M HILL submitted two technical memoranda to EPA and NJDEP in 2006, presenting the results of vapor intrusion investigations at the 115 River Road property (Appendix K). Potential vapor intrusion pathway COIs at the 115 River Road building were identified from data collected from monitoring wells screened at the top of the shallow unconfined unit. According to NJDEP vapor intrusion guidance and available literature (Rivett, 1995; NJDEP, 2007), groundwater concentrations at the top of the water-bearing zone have the highest potential of being sources for vapor intrusion. BTEX and naphthalene have been detected in groundwater near the 115 River Road building. However, ethylbenzene, toluene, and xylene concentrations have not exceeded NJDEP or EPA groundwater screening values for vapor intrusion pathways. The constituents with the highest concentrations in groundwater were naphthalene (1,600 µg/L) and benzene (280 µg/L), detected at MW-114A in March 2006. In addition to these constituents in groundwater, NAPL has been identified around and underneath portions of the 115 River Road building (Section 4.1.1).

As described in Section 2.3.11, indoor air, outdoor air and subslab sampling was performed in March and July 2006 at the 115 River Road building to evaluate potential vapor intrusion pathways associated with these constituents. Indoor air sampling results did not exceed the available NJDEP RALs and HDNLs. Based on this comparison, notification of state or local health departments was determined not necessary, and an interim remedial measure was not warranted.

Most of the constituents detected in indoor air samples at the 115 River Road property have not been detected in soil or shallow unconfined groundwater and are associated with background sources (such as motor vehicle emissions or products used in the building). These include chlorinated VOCs, 1,4-DCB, acrylonitrile, and 1,3-butadiene. These constituents are not associated with potential vapor intrusion from the Site.

Some of the constituents detected in indoor air at the 115 River Road building have been detected in soil and groundwater at the 115 River Road property (i.e., benzene and naphthalene). These constituents also have been detected at comparable levels in outdoor air and could be components of maintenance or consumer products stored and used in the buildings. The distribution of concentrations of these constituents in indoor air within the building, the presence of these constituents in outdoor air samples, the low concentrations detected in subslab samples, and the presence of other potential sources suggest that, if a vapor intrusion pathway for these constituents is present, the influence of vapor intrusion on concentrations in indoor air is not readily discernable from the influences of ambient outdoor concentrations or emission sources from indoor products. Therefore, no conclusive evidence exists of a completed soil vapor intrusion pathway from the subsurface to indoor air.

A building pressurization survey was conducted in April 2007 at the 115 River Road building. A summary of the results is provided below:

- Pressure mapping throughout the 115 River Road buildings did not identify substantial depressurized conditions that would create migration pathways into inhabited spaces. The results from this survey are consistent with previous indoor air-sampling events.
- Indoor storage of janitorial supplies containing p-dichlorobenzene was observed in buildings where indoor concentrations of p-dichlorobenzene were detected. P-dichlorobenzene has not been detected in soil or groundwater at the Site. Therefore, this constituent is not Site-related.
- Storage and evidence of use of asphalt roofing tar (which contains naphthalene) was observed in the building, which might produce emissions of naphthalene to the air that could have been detected in indoor air samples. Emissions during roofing activities conducted in early summer 2006 could have resulted in detectable concentrations of naphthalene in indoor air samples collected in July 2006.
- In Building 7 (the daycare center), observations did not identify penetrations through the floor that could transport air from the subsurface and underlying basement into the building. Therefore, a potential exposure pathway for vapor intrusion is not present in this building.
- Evidence exists that naphthalene soil vapor concentrations below the Building 8 slab (115 River Road) are above conservative screening levels. Concentrations under the slab are not producing indoor air impacts in the habitable spaces of the building.

### **2008 Supplemental Vapor Intrusion Evaluation**

CH2M HILL submitted a technical memorandum to the Agencies on June 20, 2008, presenting the results of the supplemental vapor intrusion investigation at the 115 River Road property (Appendix K).

As described in Section 2.3.11, indoor air, outdoor air, and subslab sampling was performed in March and April 2008 at the 115 River Road building. These sampling events were conducted as a follow-up to initial vapor intrusion sampling conducted in 2006.

Sampling was conducted under routine and nonroutine operating conditions. At the request of the agencies, sampling was conducted in March 2008, under nonroutine, conservative conditions, with basement fans turned off and sealed. Follow-up sampling was conducted in April 2008 under routine operating conditions, with basement fans operating, for comparison to the 2006 event which occurred under similar operating conditions.

Key conclusions from the sampling event conducted in March and April 2008 are as follows:

- Under routine operating conditions in the building, no constituents were detected at concentrations above NJDEP RAL and HDNL.<sup>17</sup> Based on these results, there is no need

---

<sup>17</sup> RALs "represent trigger levels for the initiation of prompt action at occupied buildings to further investigate the vapor intrusion pathway and/or minimize impacts to building occupants through the implementation of an interim remedial measure." The HDNLs "indicate the need for the Department [of Environmental Protection] to inform the local and/or state health departments about the site and the associated vapor intrusion related indoor air concentrations for further evaluation and possible emergency actions."

for prompt action to reduce potential exposures in the building. When sampling under conservative, non-routine conditions (basement ventilation fans turned off and sealed with plastic), concentrations of benzene in the unoccupied Building 7/8 basement were higher than the RAL and HDNL. When routine conditions were resumed in the basement, concentrations were not detected above the RAL and HDNL. Concentrations in indoor air within occupied spaces did not exceed the RAL and HDNL at any time during the sampling events.

- Most of the constituents sampled in indoor air during both the March and April 2008 sampling events were either not detected or were detected at concentrations below the lowest screening levels ( $10^{-6}$  target cancer risk level or noncancer hazard quotient of 0.1).
- Constituents detected that are confirmed to be site related include benzene, chloroform, naphthalene, and total xylenes. Several of the remaining constituents detected in indoor air were not confirmed to be site related or considered to be unrelated to vapor intrusion. Those constituents are 1,4-dichlorobenzene, acrolein, carbon tetrachloride, tetrachloroethene, tetrahydrofuran, trichloroethene, and trimethylbenzenes.
- Several constituents (benzene, naphthalene, and xylenes) were detected in some indoor air samples within the unoccupied Building 7/8 basement at concentrations above outdoor ambient air levels. These constituents have been detected in groundwater samples collected from the Quanta property and the 115 River Road property. They also have been detected in subslab samples. These results indicate that vapor intrusion conditions may be present within the basement. In addition, potential indoor sources of VOCs in the Building 7/8 basement may be contributing to concentrations in indoor air and acting as confounding factors to the vapor intrusion evaluation. Further investigation will be conducted to identify the potential migration pathways from the subsurface into the basement.
- Under routine building operating conditions, constituent concentrations in air in occupied spaces resembled outdoor ambient air concentrations, with the exception of naphthalene. This result is consistent with previous sampling events. Concentrations of naphthalene higher than outdoor ambient air levels also were detected in some indoor air samples from occupied spaces during the July 2006 sampling event.

#### 4.6.2 Building 9 (Former Lever Brothers Property)

Building 9 is located on Lot 1 of Block 99 and is part of the former Lever Brothers property. Building 9, constructed in 1999, is a two-story, 14,850-ft<sup>2</sup> steel-and-masonry structure. The building was constructed with a vapor barrier consisting of a three-ply laminate of at least two layers of high-density polyethylene (HDPE) and a high-strength core grid.

Several investigations have been conducted on Block 99, including near Building 9 (Langan, 2003-2004; GZA, 2006a, 2006b, 2007a, 2007b; CH2M HILL, 2006b). Low concentrations of several VOCs were detected at different depths in one soil boring (SB-17Q), located approximately 100 feet to the northeast of Building 9. Most of these constituents were detected at a concentration of less than 0.01 mg/kg and were qualified as estimated values ("J"-qualified). The highest concentrations of VOCs were detected in a single sample, collected from a depth of 9 to 10 feet bgs from boring SB-17Q. These VOCs included



ethylbenzene, isopropylbenzene, xylenes, and naphthalene. Naphthalene was detected at a concentration of 1,700 mg/kg at a depth of 9 to 10 feet. As discussed below, groundwater occurs approximately at a depth of 3.5 to 5 feet below grade near Building 9. Therefore, many of the detected concentrations in soil are below the water table.

Site-related NAPL stretches to the south under 115 River Road and into the northern portions of the former Lever Brothers property. In the northwestern portion of the former Lever Brothers property, NAPL is present in two separate layers, between 10 and 15 feet and between 20 and 30 feet below grade, and appears to extend underneath the footprint of Building 9 (GZA, 2007a). As previously addressed in Section 4.1.1, some false-positive TarGOST® signatures were detected in the northwestern portion of the former Lever Brothers property; collocated borings did not indicate the presence of NAPL and analytical samples showed relatively low concentrations of coal-tar-related constituents. The borings all contained a clayey peat/native soil layer known as meadow mat. The elevated TarGOST® could indicate interference from the natural organic material associated with the meadow mat.

Four shallow groundwater monitoring wells are located within 100 feet of Building 9 (MW-27, MW-108, GZA-48, and MW-5) (Figure 4-34). VOCs were not detected in two monitoring wells (MW-108 and GZA-48). Low concentrations of chloroform, TCE, and cis-1,2-DCE were detected in monitoring well MW-5. The VOC with the highest concentration detected was TCE (9.4 µg/L). Low concentrations of naphthalene were detected in groundwater at MW-5. Concentrations of naphthalene detected in groundwater at MW-27 ranged from 59 to 6,200 µg/L.

Indoor air samples were collected from Building 9 in March and October 2006 (GZA, 2007a). Samples were collected on the first and second floors of the building over a 24-hour period. VOCs detected in the indoor air samples include 2-butanone, acetone, benzene, chloromethane, dichlorodifluoromethane, n-heptane, toluene, and trichlorofluoromethane. Concentrations of the VOCs were below the NJDEP Indoor Air Screening Values. Background samples were collected during these sampling events, as well as during the 115 River Road vapor intrusion investigation that CH2M HILL conducted. Concentrations of VOCs detected in indoor air in Building 9 were similar to concentrations detected in outdoor air samples. Naphthalene was not detected in indoor air in Building 9.

Lines of evidence considered in evaluating the potential for vapor intrusion pathways included the presence of the vapor barrier—low concentrations of VOCs detected in soil and groundwater, and indoor air concentrations similar to ambient background levels. Based on these lines of evidence, no conclusive evidence exists of a completed soil vapor intrusion pathway from the subsurface to indoor air in Building 9.

### 4.6.3 163 Old River Road Building

The 163 Old River Road building (the former Jono's Restaurant and current Tomaso's Ristorante) is in Block 93 North, across River Road and west of the Quanta property. Environmental sampling near the building has indicated the presence of VOCs and SVOCs in soil and groundwater in Block 93 North.

### Initial Vapor Intrusion Evaluation

Sampling and analytical data collected as part of the RI, along with the building conditions observed during a walkthrough survey, were evaluated using the pathway-screening processes described in the EPA draft vapor-intrusion guidance document (EPA, 2002a) and the NJDEP vapor intrusion guidance (NJDEP, 2007). Key findings from this initial evaluation are described below.

Available data suggest that VOCs in groundwater at this property are not likely to be transported via the vapor intrusion pathway to indoor air at concentrations that would represent a potential risk to human health. Volatile constituents were not detected in shallow groundwater at concentrations greater than 2 µg/L, with the exception of naphthalene, which was detected in groundwater at 140 µg/L in 2005 at monitoring well MW-111A, approximately 60 feet from the building. The maximum allowable groundwater screening concentration for naphthalene presented in the EPA vapor intrusion guidance is 150 µg/L.

In addition, available soil data indicate that a vapor intrusion pathway is not present as a result of VOCs in soil. Volatile constituents were detected in low levels in soil within 100 feet of the building. The highest concentrations in soil generally were detected around 0.1 mg/kg (ethylbenzene and toluene) to 0.26 ppm (benzene). The constituent with the highest concentrations detected is naphthalene with 12 mg/kg (from SB-26, 30 feet from the building, 9 to 10 feet bgs) and 101 mg/kg (from SB-27, 45 feet from the building). As described previously, the groundwater table is at a depth of 3.5 to 4 feet bgs on this property, so these detected constituents in soil are within the saturated zone.

The following building characteristics observed during the building walkthrough would preclude a potential vapor intrusion pathway:

- The slab underlying the building is relatively thick (from 6 inches to 2 feet), and is in good condition, with relatively few penetrations.
- Inhabited areas are generally elevated 1.5 to 3 feet above the ground surface. There is an approximate 4-inch annular space above the floor in the inhabited areas. This annular space is located under the dining room floor and is filled with insulation. If soil vapor were able to migrate through the slab, it would still have to travel through this insulation-filled space and then the dining room floor in order to reach indoor air.
- The indoor air volume is relatively large and is connected throughout the building. The dining area contains an upstairs portion, providing an approximate ceiling height of 20 feet. The ceiling height in the kitchen and store room is approximately 8 to 10 feet.
- The kitchen hoods and exhaust fans are operational when the building is occupied. There are also ceiling fans in the dining areas. The exhaust fans and ceiling fans increase the air exchange rate within the building.

### 2007 Groundwater Sampling and Utility Survey

As a follow up to the initial evaluation of the potential for indoor vapor intrusion pathways near the 163 Old River Road building, six groundwater samples were collected in June 2007, as described in Section 2.3.11,. The primary constituents detected in groundwater were

BTEX and PAHs. The analytical results and a complete discussion of the sampling and subsequent evaluation are presented in the “Updated Vapor Intrusion Evaluation, 163 River Road (Former Jono’s Restaurant), Block 93, Edgewater, NJ” technical memorandum (CH2M HILL, 2007k), included in this RI Report as part of Appendix K.

An evaluation of the potential for a vapor intrusion pathway into the 163 Old River Road building was conducted using the groundwater data collected in June 2007. The evaluation consisted of the following steps:

1. Identify the constituents of interest for vapor intrusion.
2. Compare the estimated soil gas concentrations with conservative screening levels.
3. Develop the conceptual model of the potential vapor intrusion pathway (for the constituents of interest) and estimate soil gas concentrations corresponding to the concentrations in groundwater.

The results from the June 2007 groundwater-sampling event and subsequent evaluation reinforced the overall assessment originally presented in the April 2007 vapor intrusion evaluation. Soil gas concentrations of naphthalene – estimated from concentrations detected in groundwater samples collected several feet below the water table near the footprint of the building – were lower than site-specific risk-based screening levels. These screening levels are based on the individuals with the highest frequency and duration of potential exposure (workers in the restaurant).

In order to evaluate whether preferential pathways could be a factor in contributing to a vapor intrusion pathway at the 163 Old River Road building, a geophysical survey was performed in June 2007 to identify subsurface utilities that could be located near the Building. Based on this survey, the presence of subsurface features such as water, gas, and sewer lines does not appear to affect the potential for a vapor intrusion pathway into the Building.

### **2008 Vapor Intrusion Sampling**

Indoor air, subslab soil gas, and outdoor air samples were collected in March 2008 as described in Section 2.3.11 as a supplemental evaluation of the potential for complete indoor vapor intrusion pathways to exist near the 163 Old River Road building.

The results from this sampling event indicate that a potential vapor intrusion pathway is not causing unacceptable concentrations of site-related constituents in indoor air. These results are consistent with the results from the two previously conducted evaluations of the potential vapor intrusion pathway at the building. Complete results for this work are presented in the draft “Vapor Intrusion Evaluation March 2008 Sample Results, 163 Old River Road (Former Jono’s Restaurant), Block 93, Edgewater, NJ” technical memorandum (CH2M HILL, 2008d), included in Appendix K of this Final RI Report. The key conclusions from this supplemental vapor intrusion evaluation are the following:

- No constituents were detected in indoor air at concentrations above NJDEP RALs and HDNLs. Based on these results, there is no need for prompt action to reduce potential exposures in the building.

- Most of the constituents sampled in indoor air during the March 2008 sampling event were either not detected or were detected at concentrations below the lowest screening levels (see Table 1) and were similar to outdoor ambient air concentrations.
- Constituents detected above the lowest screening criteria in either indoor air or subslab soil gas that are confirmed to be site related are chloroform, ethylbenzene, naphthalene, tetrachloroethene, and total xylenes. Several of the remaining constituents detected above the lowest screening criteria in either indoor air or subslab soil gas were considered to be not site related or considered to be unrelated to vapor intrusion. Those constituents are acrolein, benzene, carbon tetrachloride, n-propylbenzene, tetrahydrofuran, and trimethylbenzenes.
- Most of the constituents detected above screening criteria in subslab soil gas were not detected above the lowest screening criteria in indoor air. These constituents are 1,3,5-trimethylbenzene, ethylbenzene, n-propylbenzene, tetrachloroethene, tetrahydrofuran, and total xylenes.
- Constituents detected that are confirmed to be site related include benzene, chloroform, naphthalene, and total xylenes. Several of the remaining constituents detected in indoor air were not confirmed to be site related or considered to be unrelated to vapor intrusion. Those constituents are 1,4-dichlorobenzene, acrolein, carbon tetrachloride, tetrachloroethene, tetrahydrofuran, trichloroethene, and trimethylbenzenes.

## 4.7 Extent of OU1

### 4.7.1 Horizontal Extent of OU1

The maximum extent of soil and groundwater impacts (including the presence of free and residual NAPL) has been delineated and is depicted in Figure 4-41. The northern boundary of OU1 is defined by the extent of NAPL and Site-related COIs in subsurface soils and groundwater, as well the area of the arsenic liner on the former Celotex property. The southern boundary of OU1 defines the extent of dissolved-phase Site-related constituents (approximately the same as the location of a groundwater convergence on the northern portion of the former Lever Brothers property).

As discussed in Section 4.1.5, P/A material on the former Lever Brothers property is not included within the extent of OU1 because it has not emanated from the Quanta Site. At the southern boundary of OU1, the leading edge of dissolved-phase NAPL constituents are collocated with similar impacts related to documented source areas associated with former operations on the Lever Brothers property south of the convergence. As defined by EPA in the AOC, OU1 is defined as “the areas of the Site, including soil, debris and groundwater, westward of the Hudson River Bulkhead”; therefore the eastern boundary of OU1 is the wooden bulkhead on the Quanta property. Site-related impacts in sediment and surface water in the Hudson River make up OU2 and are part of a separate RI/FS. To the west, the definitive extent of Site-related impacts will be determined during future investigations proposed as part of the SRI; however, existing data suggest that Site-related impacts in the area of Block 93 Central appear to be limited to the eastern portions of this property.

## 4.7.2 Vertical Extent of OU1

### Surface Soil Impacts

Site-related impacts to soil in the interval of 0 to 2 feet bgs are described below for each of the properties comprising OU1.

- Soil currently within the interval of 0 to 2 feet bgs on the former Celotex property consists entirely of fill material imported during property redevelopment within the past several years; therefore, soil does not contain constituents that have migrated from operations at the Site.
- Soil within the interval of 0 to 2 feet bgs on the 115 River Road property has the potential to have been impacted by coal-tar operations due to surficial transport of soil across the property boundary.
- Soil within the range of 0 to 2 feet bgs on the Lever Brothers property does not contain Site-related constituents. At all times during which historical maps and aerial photographs document active operations on the Quanta and former Celotex properties, separate operations are documented or depicted on the 115 River Road property, between the Quanta and former Celotex properties, and on the former Lever Brothers property. Buildings and other surface improvements on these properties associated with historical operations physically would have prevented the direct overland migration of surface soil from the northern properties to the surface of the former Lever Brothers property. Cinder investigation results confirm the lack of waste material on the Lever Brothers property related to the former sulfuric acid plant operation.
- Soil within the range of 0 to 2 feet bgs on the Quanta and Block 93 North properties is impacted by constituents from former operations. These properties fall within the historical footprint of Site operations.
- Limited impacts identified within the range of 0 to 2 feet bgs on the Block 93 Central property are most likely a result of rail activity and loading and unloading associated with former Spencer-Kellogg operations. However, minor erosion may have resulted in incidental transport of Site-related constituents to this property.
- Soil within the range of 0 to 2 feet bgs on the Block 93 South property does not contain Site-related constituents. The presence of active operations between former Site operations and Block 93 South has prevented the migration of Site-related constituents between these areas.
- Soil within the range of 0 to 2 feet bgs within the footprint of River and Gorge Roads consists of fill material imported during road construction in the 1990s and is elevated above the ground level of the former operations; therefore, these materials do not contain Site-related constituents.

### Subsurface Soil Impacts

Subsurface soil (greater than 2 feet bgs) has been impacted by free or residual NAPL or Site-related constituents to a maximum depth that corresponds with the top of the silty-clay confining unit (approximately 30 feet bgs). To the south and southwest, less-viscous coal tar

has migrated vertically and has pooled in low-lying areas associated with the top of the silty clay. In the west, central, and eastern portions of OU1 (adjacent to the bulkhead), more viscous tars are less mobile and have generally only reached a depth of approximately 8 feet bgs.

### **Groundwater Impacts**

Dissolved-phase constituents in groundwater are limited generally to the shallow overburden fill and native sand deposits overlying the silty-clay confining unit. Deep sand beneath the confining unit is impacted with chlorinated solvents that are the result of an offsite upgradient source unrelated to OU1. Low levels of PAHs and BTEX compounds have been detected in the deep sand adjacent to the Hudson River and at even lower concentrations in the central portion of the OU1. Adjacent to the Hudson River, the deep sand unit is shallower and overlain by only 10 feet of silty clay as it pinches out against a bedrock high to the north. These impacts are localized to this area and are the result of the migration of lower levels of these constituents in groundwater from the overlying shallow unit and the fact that the well screen at this "deep sand" location (MW-116DS) is partially screened within the silty clay at a depth of only several feet below the overlying shallow groundwater. The distribution of the deep sand in the shoreline areas and the extent of coal-tar impacts observed within and above these deposits will be addressed as part of the SRI.

# Fate and Transport

---

The purpose of this section is to characterize the fate and transport processes present at the Site, as well as the effect these processes have had and will continue to have on constituent migration in the absence of potential future remedial action. The environmental persistence or degradation (fate), and the rate and direction of constituent movement (transport) in the surface and subsurface environment can be characterized based on knowledge of specific constituent and media properties.

As described in Section 4.2, COIs at the Site include PAHs, non-PAH SVOCs, VOCs (aromatic and chlorinated), inorganic constituents (metals and ammonia), and pesticides and PCBs. The fate and transport mechanisms for COIs at the Site and the characteristics of the COIs that govern these mechanisms are described in Sections 5.1 and 5.2, respectively. The observed and predicted future fate and transport of the COIs are discussed in Sections 5.3 to 5.5.

## 5.1 General Mechanisms of Fate and Transport

The probable behavior of constituents at the Site is determined by their physical, chemical, and biological interactions with the environment. The mobility and persistence of COIs at the Site are two key characteristics in determining probable behavior. Mobility is the potential for a constituent to migrate in environmental media, and persistence is a measure of how long a constituent will remain in the environment in its current form. The primary fate and transport mechanisms that control the mobility and persistence of the COIs are aqueous solubility, sorption, volatility, and degradation. Mobility and persistence of COIs at the Site are discussed below in the specific sections for soil and groundwater transport.

### 5.1.1 Aqueous Solubility

Aqueous solubility is the maximum concentration of a constituent that will dissolve in pure water at a reference temperature. If a constituent has a high aqueous solubility, a large amount of that chemical will dissolve in water at the reference temperature. In addition to temperature, pH, and redox potential (as measured with ORP) can also influence the solubility of select constituents. The actual solubility for individual constituents in a multicomponent NAPL such as coal tar is governed by Raoult's Law, which states that the effective solubility of a constituent in a mixture is equal to its individual solubility multiplied by its mole fraction. After applying the melting point and mole fraction corrections, the resulting solubility for many constituents is significantly lower than the corresponding pure solid and pure liquid values for the individual constituents comprising the NAPL. The tendency of a compound to dissolve in water is a key component to understanding its ability to be transported in the subsurface.

Site NAPL samples were determined to consist of a wide range of pyrogenic and some petrogenic material consistent with coal carbonization tars, coke oven tars and creosotes

(Table 2-5; META, 2004, 2006a, b). The samples include more than 48 detected compounds, including naphthalenes, fluorenes, phrenanthracene, anthracenes, dibenzothipenes, carbazole, fluoranthene, pyrene, fluorenes, pyrenes, benz(a,b, and k)anthracenes, chrysenes, perylene, perylenes, benzenes, styrene, toluene, methyl phenols, methyl naphthalenes, trimethyl benzenes, and some metals (arsenic, chromium, and lead). Many of these constituents will leach and dissolve in water based, in large part, on their individual aqueous solubility. Many of these constituents have been detected in the adsorbed (in soil) and/or dissolved (in groundwater) state at the Site.

### **5.1.2 Advection**

Advective groundwater flow is an important factor in the transport of dissolved-phase constituents in groundwater and, to a lesser extent, in the migration of NAPL. The lateral and vertical flow components of groundwater will influence the direction and rate in which dissolved-phase constituents will move in groundwater. These hydrodynamic forces also can promote or resist NAPL migration, however, as explained further in Section 5.1.8. These forces are usually minor compared to gravity and capillary pressures (Cohen and Mercer, 1993).

It is possible that historical groundwater flow paths varied from those observed today as a result of both recent and historical development in the area (e.g., paving, filling, drainage, and bulkhead construction, demolition, and modification). However, understanding historic groundwater flow paths is an uncertainty that cannot be resolved. Therefore, quantitative hydraulic head data that has been collected from the Site as part of the RI has been used for the purpose of evaluating the fate and transport of COCs in groundwater at the Site.

Based on data collected during the RI, unconfined groundwater, in the vicinity of the Site where impacts have been observed, currently flows radially outward from an area of increased recharge in the western portion of the Quanta property toward the Hudson River (shown in Figure 3-5) at an average linear flow velocity of 0.55 foot per day (Section 3.3). Groundwater flow within the confined deep sand unit has a more uniform easterly flow direction (shown in Figure 3-6) with an average linear flow velocity of 0.02 foot per day (Section 3.3). Groundwater within both units eventually discharges to the Hudson River. Strong upward hydraulic gradients have been consistently measured between the shallow unconfined water bearing unit and the confined deep sand unit, confirming that these units are not appreciably hydraulically connected. The connection of deep sand groundwater impacts in the vicinity of the bulkhead and the Hudson River will be addressed as part of the SRI. The effects of tidal fluctuations in the Hudson River do not significantly impact the direction and flow velocity of groundwater at OU1 (Section 3.3).

As detailed further in Section 5.1.3, the rate of transport for COIs identified at the Site can be significantly slower than that of bulk groundwater flow due to retardation of individual constituents through sorption processes, as well as other attenuation mechanisms such as volatilization, degradation, and bioaccumulation.

### **5.1.3 Sorption**

Sorption is the tendency for constituents to attach to surfaces through a weak electrical charge (adsorption), or be incorporated into the atomic structure of the solid media



(absorption) through which the constituents migrate. Sorption processes are often reversible, and constituents could detach (desorb) from surfaces. Subsurface materials that are likely to adsorb constituents include clay minerals, iron/aluminum hydroxide minerals, and organic materials (including peat). All of these potential sorption media have been identified in the subsurface at OU1. In the presence of moisture, inorganic compounds adsorb onto iron, manganese, and aluminum oxyhydroxide or oxide coatings on soil and sediment grains. Adsorption of metals onto solids can be irreversible, as in the case of grain coatings.

The conventional measure of sorption is the distribution coefficient ( $K_d$ ) of soil and geologic material for the constituent. The  $K_d$  for organic chemicals is calculated as the product of the organic carbon to water partition coefficient ( $K_{oc}$ ) for the constituent and the fraction of organic carbon ( $f_{oc}$ ) in soil. In general, chemicals with a  $K_{oc}$  greater than 10,000 mL/g (e.g., many SVOCs) have high degrees of adsorption and, consequentially, low mobility; whereas, chemicals with a  $K_{oc}$  lower than 1,000 mL/g (e.g., many VOCs) exhibit a lower tendency to be absorbed by organic materials and, consequently, exhibit higher mobility. Elevated  $K_{oc}$  values also indicate a greater potential for bioaccumulation. The average organic carbon content of soils at the Site has been measured at 94,000 mg/kg, or 9.4 percent. These elevated levels of organic carbon at the Site are a result of the presence of fill material containing organic debris such as coal, coal ash, and wood, as well as an abundance of native organic matter associated with former marsh and river environments. The presence of high levels of organic carbon will significantly reduce the mobility of a constituent in soil due to its relationship with  $K_d$ .

Based on the data collected at the Site, the presence or absence of NAPL in a sample does not correlate with high or low TOC values. Seventy-three percent of samples with elevated TOC concentrations occurred in samples with slag and/or coal fragments, but only 27 percent contained observed NAPL. For example, a TOC value of 47,500 mg/kg was found in a sample collected from SB-30 at a depth interval of 1.5 to 3.5 feet, logged as having no slag or coal. But two samples collected from SB-28 containing slag had significantly higher TOC values — of 300,000 and 305,000 mg/kg. Table 5-3 has been incorporated to show sample descriptions for intervals analyzed for TOC.

TOC sample selection was based upon data needs during the supplemental investigation to determine the nature, extent, and origin of the cinder/ash and reddish-purple soils. During this field effort, all soils samples collected were analyzed for TOC in order to evaluate the impacts that cinder/ash deposits have on groundwater.

The migration rates of dissolved organic constituents range widely between different compounds because of their degree of adsorption to soil and organic matter. Typically, because of their tendency to adsorb onto geologic media, constituents will not move as rapidly as groundwater. This relationship is called retardation and can be characterized by the retardation factor ( $R$ ).  $R$  is a function of the  $K_d$  value of the constituent of interest and the physical characteristics of the water-bearing unit.

The effect of adsorption reactions on migration rates for both inorganic and organic constituents is typically quantified through the use of the  $R$ , which can be estimated from the constituent-specific partition coefficient ( $K_d$ ), soil bulk density ( $\rho_b$ ), and porosity ( $n$ ) per the following equation (Fetter, 1988):

$$R = 1 + (\rho b/n) \times Kd$$

The velocity of constituent migration ( $vc$ ) can then be estimated from the linear velocity ( $v$ ) as follows (Fetter, 1988):

$$vc = v/R$$

Using the calculated average linear flow velocity ( $v$ ) for shallow groundwater at the Site toward the Hudson River during low tide (0.55 foot/day [Section 3.3]), retardation factors have been calculated for representative organic COIs and are summarized in Table 5-2.

Adsorption plays a key role in controlling inorganic constituents such as arsenic in groundwater. However, the determination of  $Kd$  values and, thus, Site-specific retardation factors for inorganic constituents is much more complicated because inorganic constituents are affected by a number of variables including pH, redox conditions, iron oxide content, cation exchange capacity, major ion chemistry, as well as the organic content of the soil. For this reason, single generic  $Kd$  values cannot be applied for metals like arsenic in the same way as they are for organics, such as benzene and naphthalene, because  $Kd$  values for inorganic constituents can vary significantly across distances and depths. Local groundwater differences in dissolved oxygen concentrations, redox potential (Eh), and pH influence the actual state of inorganic constituents and their concentrations in Site groundwater samples (and, therefore, their exceedances of regulatory criteria). Furthermore, the state of certain metals and their adsorption capacities can have a dramatic effect on the dissolved concentrations of other metals.

Redox potential as Eh is a measurement of the redox potential of groundwater. Eh indicates if an element or compound is likely to be in a reduced valence state (more electrons) or in an oxidized state (fewer electrons). Eh can be derived from ORP measurements taken during groundwater sampling by the addition of a factor consummate for the type of reference electrode used in the field to measure ORP.<sup>18</sup> The valence state of elements or compounds within a given system will dictate the types and intensity of reactions that involve the transfer of electrons (redox reactions). Reduced groundwater conditions (Eh values less than zero) are created in the presence of significant sources of organic material, such as coal tar, as well as natural sources of organics, such as peat. As these sources are consumed through natural microbial processes, electron acceptors in groundwater such as oxygen, nitrate, manganese ( $Mn^{2+}$ ), ferric iron ( $Fe^{3+}$ ), and sulfate are reduced through their acceptance of additional electrons. Conversely, more oxidized groundwater conditions (Eh values greater than zero) are common in systems where there is an excess presence of oxygen or another oxidant for which there is not a sufficient supply of electrons to promote their reduction. Redox potential values measured in a given well provide an indication of the potential of the groundwater for accepting or donating an electron. Metals common to the Site that exist in the natural environment in more than one valence state include arsenic and iron.

The combination of pH and Eh typically controls the mobility and concentration of metals (e.g., iron), and metalloids (e.g., arsenic), in the groundwater. For example, in groundwater with higher redox potentials (Eh is greater than zero) arsenic is dominated by the anionic species As(V), which has a greater affinity for adsorption to iron oxyhydroxides. As the pH

---

<sup>18</sup> During all groundwater-sampling events performed as part of the RI, a silver-chloride probe was used to measure ORP; thus Eh was derived from ORP values by adding 199 mV.

decreases and/or lower redox potentials are present (Eh is less than zero), groundwater will become reducing. As a result, the more reduced and typically neutral species, As III, will dominate and with this loss of charge will become increasingly likely to be desorbed and, thus, more mobile in groundwater. In addition, the tendency of iron to dissolve in slightly acidic (pH is less than 7) groundwater where Eh values are between 0 and -100 will increase the mobility of arsenic as the dissolution of iron oxyhydroxides decreases the availability of arsenic adsorption sites.

The median Eh values for each well were calculated for those wells screened across the water table (shallow), as well as those screened above the silty-clay confining unit using the ORP measurements collected during low-flow sampling performed as part of the RI activities between December 2005 and October 2006. Median Eh values measured in groundwater during the RI range from +423 mV at monitoring well ACMW-1 to -165 mV at monitoring well MW-36 in the central portion of the former Lever Brothers property. These data have been plotted and contoured in Figures 5-1 and 5-2, respectively. In general, intermediate and shallow groundwater redox potentials (Eh values) within the central portion of the Site range from approximately 0 to -100 mV where coal tar is present, and the resulting elevated concentrations of dissolved-phase organics have resulted in a lowering of redox potentials. Farther to the south (northern portion of the former Lever Brothers property), north (former Celotex property), and east along the bulkhead, groundwater becomes more oxic (Eh values of approximately +50 to +300 mV). Still farther south in the vicinity of the P/A material associated with the former Lever Brothers property (MW-4, MW-32, and MW-36), Eh values are between -125 and -165 mV. These results indicate the presence of an additional area of moderately reducing groundwater conditions that likely have resulted from the biological degradation of the P/A material and/or organics associated with the former Lever Brothers property.

The median of pH values measured from each well during low-flow sampling performed as part of the RI between December 2005 and October 2006 were calculated for those wells screened across the water table (shallow), as well as those screened above the silty-clay confining unit (intermediate). These data have been plotted and contoured in Figures 5-3 and 5-4, respectively. The pH of shallow and intermediate groundwater throughout the majority of the Site is slightly acidic to neutral (pHs of approximately 6.0 to 7.0). A limited area of alkaline groundwater (pH of approximately 8.1) is present in groundwater in the western portion of the Quanta property near MW-102A. In this area a collocated well screened across slightly deeper portions of the unconfined unit, indicates groundwater is slightly acidic with a pH ranging from 6.2 to 6.4. At MW-112A an alkaline pH value of 10.3 was observed and is believed to be a localized phenomenon resulting from grout contamination within the borehole. As a result, this well has not been included in the contouring presented in Figure 5-3. As noted above, immediately adjacent to this well, pH values are slightly acidic at MW-112B, where the well screen interval is only marginally deeper and the pH data are likely more representative of groundwater conditions in this area. To the north and south of the Quanta property are significant areas transitioning to suboxic (Eh > +200 mV), acidic groundwater. To the north along the southern boundary of the former Celotex property within the mapped historical footprint of the former acid plant operations and extending to the south to the MW-113 well cluster on the Quanta property is a widespread area of acidic groundwater with a pH range of 3.9 to 5.2. In the northern portion of the former Lever Brothers property near the MW-107 well cluster and extending

farther to the south to the MW-115 well cluster, acidic conditions are also present in shallow and intermediate groundwater where the pH ranges between 4.2 and 5.7.

The role of redox and pH chemistry and the effects of sorption on both organic and inorganic constituents at the Site are discussed in detail in Sections 5.4 and 5.5.

Both organic and inorganic constituents can be released to groundwater via matrix diffusion. Matrix diffusion entails the physical flux of a particular contaminant within a system, involving several mostly atomic-level drivers but including the gradient created by a concentrated dissolvable species surrounded by more-dilute bulk water. In general, matrix diffusion will be a minor factor in porous materials where advective flows dominate the movement of contaminants in groundwater and sorption processes are anticipated to be more significant. Matrix diffusion plays less of a role for contaminants with low solubilities, such as PAHs and metals.

### **5.1.4 Leaching**

Leaching is the process by which constituents are released from the solid phase into the water phase under the influence of mineral dissolution, desorption, complexation processes as affected by pH, redox, dissolved organic matter, and microbiological activity.

Constituents could leach from the soil as a result of percolating precipitation (i.e., infiltration) or from groundwater flowing through the soil. The degree to which a chemical is leached is strongly influenced by the tendency of the chemical to partition to the solid or aqueous phases, which is largely a function of its solubility and affinity for adsorption.

The loss of soluble substances and colloids from the top layer of soil can occur by percolating precipitation. The materials lost are carried downward (elluviated) and are generally redeposited (illuviated) in a lower layer. This transport results in a porous and open top layer and a dense, compact lower layer. The rate of leaching increases with the amount of rainfall. All of the COIs at the Site, with the exception of the larger PAHs, some pesticides, and PCBs, have the potential to leach from soil.

### **5.1.5 Volatilization**

Volatilization is the tendency for some constituents, particularly VOCs, to change from a liquid or adsorbed state to a gas. Constituents in soil gas at the Site could be derived from the presence of coal tar and petroleum products and related constituents adsorbed to soil or dissolved in groundwater. VOCs in soil gas can migrate and ultimately dissolve into the groundwater or soil moisture, resorb onto soil particles, and/or escape to the atmosphere. The partitioning of VOCs in the vadose zone between the solid, gas, aqueous, and NAPL phases depends on the volatility and solubility of the compound, the moisture content of the soil, and the type and amount of soil solids present (Cohen and Mercer, 1993).

A conventional measure of volatility is Henry's Law Constant ( $K_h$ ). Compounds with  $K_h$  values higher than  $10^{-3}$  atmosphere-cubic meter per mole ( $\text{atm}\cdot\text{m}^3/\text{M}$ ) (e.g., VOCs) are expected to volatilize readily from water to air; whereas, those with  $K_h$  values lower than  $10^{-5}$   $\text{atm}\cdot\text{m}^3/\text{M}$  (e.g., SVOCs) are relatively nonvolatile (EPA, 1991). The Henry's Law Constant for a given constituent is a function of temperature. At higher temperatures, constituents more readily volatilize. The ability of a compound to volatilize is also a

function of its molecular weight. Compounds with molecular weights greater than 200 grams per mole (g/M) do not readily volatilize.

The dominant process for the attenuation of VOCs in shallow soil, sediment, and surface water is volatilization into the atmosphere. For this reason, VOCs infrequently occur in shallow soil, sediment, and surface water. VOCs in shallow groundwater are likely to volatilize into soil gas overlying the water table.

Volatilization of lower-chained compounds from NAPL (e.g., benzene and toluene) will result in lowering the viscosity of the NAPL. A lower viscosity, in turn, reduces the mobility of NAPL in the subsurface.

Volatilization currently is not considered a significant part of potential constituent migration at the Site. Site-related constituents at OU1 have been in place for at least 25 years and potentially up to 130 years. Constituents with the tendency to volatilize (VOCs and some SVOCs) have been subject to volatilization for many years. Tar present in surface soils is generally solid and almost rock-like, indicating that many of the VOCs and SVOCs already have volatilized. Heating the tar in surface soil during warm weather increases the rate of volatilization.

### 5.1.6 Erosion

Erosion processes can affect the distribution of soil-bound particulates in the environment and, thus, influence the distribution of soil contaminants. High winds can scour fine particles from the soil surface and redistribute these particles downwind. Similarly, runoff resulting from heavy precipitation events can scour fine soil particles from surface soils, eventually depositing the particles downgradient during sedimentation downstream.

The potential for these mechanisms to transport significant amounts of constituents at the Site is minimal. Wind and water erosion of surface soil at the Site are not significant because only small areas of exposed soils exist. Detailed descriptions of the surface features on each property in OU1 are provided in Section 3.1 of this report. The properties surrounding the Quanta property primarily are covered with buildings and parking lots. Also, a few grassy areas are on the former Lever Brothers property. Most of the Quanta property is covered with vegetation, gravel, or asphalt. The areas with exposed soils are mostly covered with large pools of standing water. These types of ground cover help prevent fugitive dust emissions.

### 5.1.7 Degradation

The degradation of organic constituents in the subsurface due to natural processes also has a significant effect on their ability to migrate in groundwater. Degradation is the transformation of one compound to another by abiotic processes such as hydrolysis or photolysis, or by biotic processes such as biodegradation. Degradation rates are referred to as half-lives, and account for the combined effect of all degradation processes.

Hydrolysis is the decomposition of organic compounds by interaction with water. Hydrolysis literally means "splitting apart with water" and is facilitated by heat, enzymes, catalysts, and low pH. Hydrolysis results in the formation of new compounds from parts of

the original molecule when the  $[\text{OH}^2-]$  ion from water bonds with one part of the compound, and the  $[\text{H}^+]$  ion bonds with another part.

Photolysis is the process by which a compound undergoes a chemical change as the result of the absorption of a photon of light energy. Generally, only ultraviolet photons can provide enough energy for direct photolysis.

Biodegradation occurs when microorganisms convert one chemical to another as part of the respiration process. Biodegradation is an important component of the natural attenuation of organic compounds. Aerobic biodegradation is the breakdown of organic compounds by microorganisms that use oxygen for respiration. Aerobic microorganisms use oxygen as an electron acceptor, and break down organic compounds (electron donor) into smaller organic compounds, often producing carbon dioxide and water as byproducts.

Anaerobic biodegradation is the breakdown of organic compounds by microorganisms when oxygen is not present. Anaerobic microorganisms use nitrate, sulfate, iron, manganese, and carbon dioxide as electron acceptors, and break down organic chemicals into simpler organic compounds, often producing carbon dioxide and methane as by-products. The sequence by which the anaerobic pathway proceeds is based on the free energy of the electron acceptor. The specific electron acceptors used in microbially mediated processes will depend on their energy-yielding potential. As higher-energy-yielding electron acceptors are depleted, progressively lower-energy-yielding electron acceptors are used. The order in which these electron acceptors are reduced in an anaerobic environment begins with nitrate, then manganese ( $\text{Mn}^{2+}$ ), ferric iron ( $\text{Fe}^{3+}$ ), sulfate, and finally carbon dioxide. The presence or absence of these electron acceptors, or their by-products, as well as the redox potential (Eh) of the groundwater (as measured by ORP), provide an indication of the state of microbial activity. When biodegradation is occurring, redox potentials are generally lower in the interior of the plume where the electron acceptors have been consumed in the biodegradation process. Where microbial activity is sufficient, constituent concentrations in groundwater will decrease along flow paths to below regulatory standards, resulting in a stable plume.

Microbial activity in groundwater at the Site is evidenced in the reduction of dissolved oxygen and Eh values (less than 0 mV) within the interior of the organic plumes. In addition, a significant portion of the TKN (around 60 percent), as measured in groundwater during the October 2006 groundwater sampling event (Table 4-10), throughout the majority of the Site is organic nitrogen (a by-product of microbial activity), further supporting the assertion that microbial activity is an important factor in the reduction of organic constituents in groundwater at the Site. These conditions would be anticipated in the subsurface at the Site where significant sources of natural organics, as well as organic compounds associated with former Site operations and fill material, are present and promoting microbial activity.

Degradation in the vadose zone is a function of multiple factors including moisture content of the soil, temperature, mineralogy, and availability of electrons and microorganisms.

Some anaerobic microorganisms also can break down organic compounds through the process of fermentation. During fermentation, the organic chemical acts as an electron acceptor, rather than an electron donor.

### 5.1.8 Non-Aqueous Phase Liquid Mobility

NAPL exists at the Site as “light” DNAPL in residual<sup>19</sup> and free-phase states and as non-Site-related LNAPL in one location (MW-7). NAPL at the Site is a separate-phase hydrocarbon liquid that is slightly denser than water (specific gravities measured from five NAPL samples ranged from 1.0505 to 1.1293). DNAPL can migrate in the subsurface by three distinct forces: (1) pressure due to gravity (sometimes referred to as buoyancy or hydrostatic pressure), (2) capillary pressure, and (3) hydrodynamic pressure (also known as the hydraulic or viscous force). Each force could have a different principal direction of action, and the subsurface migration of this material is determined by the interaction of these forces. DNAPL migration can be prevented or retarded when these forces act in opposite directions. For example, high capillary pressure in a low-permeability unit might prevent continued downward migration of DNAPL despite the force of gravity.

The ability of NAPL to migrate in the subsurface is controlled by a number of factors including the level of NAPL saturation, interfacial tension, density, and viscosity, as well as the capillary pressures and permeability of the subsurface media. The hydrodynamic force due to hydraulic gradient also can promote or resist NAPL migration; however, these forces are usually minor compared to gravity and capillary pressures (Cohen and Mercer, 1993).

When released to the subsurface, gravity causes DNAPL to migrate downward through the vadose zone as a distinct liquid. This vertical migration typically is accompanied by lateral spreading due to the effects of capillary forces and spatial variability of the medium (e.g., layering). As DNAPL sinks through the vadose zone, a significant portion the NAPL is trapped in the porous media at residual saturation due to interfacial tension effects and capillary pressure. Upon encountering the capillary fringe, DNAPL will tend to spread laterally and accumulate until the gravitational pressure developed at the base of the accrued NAPL exceeds the threshold entry pressure of the underlying water-saturated medium. When this occurs, DNAPL will displace water and continue its migration under pressure and gravity forces. Preferential spreading will occur where DNAPL encounters relatively permeable layers, fractures, or other pathways that present less capillary resistance to entry than the underlying less-permeable strata.

Given sufficient saturation levels, DNAPL can often migrate downward within the saturated zone until it reaches a barrier layer upon which it might continue to flow laterally under pressure and gravity forces. Transport of DNAPL upon a capillary barrier, therefore, will be governed in large part by the slope of the barrier layer (Cohen and Mercer, 1993). However, because the movement of DNAPL in the subsurface is inversely related to fluid viscosity, the rate and distance of DNAPL movement due to gravity could be significantly greater for low-viscosity (thin) DNAPLs than for high-viscosity (thick) DNAPLs. Subsurface NAPL viscosity can change with time, typically becoming thicker as the more volatile, thinner components evaporate and dissolve from the NAPL mass (Cohen and Mercer, 1993).

NAPL will occur in the subsurface as a free-phase or a residual liquid. Residual NAPL is immobile, trapped by capillary forces within saturated soil pore spaces, and will not move

<sup>19</sup> Residual saturation of NAPL is the saturation ( $V_{\text{NAPL}}/V_{\text{voids}}$ ) at which NAPL is immobilized (trapped) by capillary forces as discontinuous ganglia under ambient groundwater-flow conditions. Specifically, residual saturation results from capillary forces and depends on several factors, including (1) the media pore-size distribution, (2) wettability, (3) fluid viscosity ratio and density ratio, (4) interfacial tension, (5) gravity/buoyancy forces, and (6) hydraulic gradients (Cohen and Mercer, 1993).

into a monitoring well open to the atmosphere. Free-phase NAPL is present under pressures greater than atmospheric pressure and, therefore, will accumulate in wells that are open to the atmosphere. Free-phase NAPL will either have the ability to migrate, or it could be immobilized due to its physical properties (such as elevated viscosities) that will not allow it to overcome the adjacent pore pressure or the presence of down-dip (underlying or adjacent) impermeable barriers where it could pool (i.e., the NAPL will be stratigraphically trapped). Residual saturation levels determined at other sites with coal tar and creosote range from 5 to 50 percent of the total pore volume (EPA, 1992a; Jackson et al., 2004), while immobilized pools of NAPL may exist at localized saturation levels of up to 70 percent (U.K. Environment Agency, 2003).

Mobility of NAPL at the Site is discussed in detail in Section 5.3.

## 5.2 Representative COIs

In addition to residual and free-phase NAPL observed at the Site, individual COIs were identified for soil and groundwater, as discussed in Section 4. COIs include constituents both related and unrelated to former Site operations and consist of a wide range of PAHs, non-PAH SVOCs, VOCs (aromatic and chlorinated), inorganics, pesticides, and PCBs. Table 5-1 presents the physical and chemical properties and related coefficients of the COIs at the Site. To illustrate the fate and transport of all COIs, representative constituents from each group of COIs that were detected above screening levels most frequently and/or those that represent the more potentially mobile constituents for each analyte group detected at the Site are discussed in detail in the following subsections. These representative COIs include: benzo(a)pyrene and naphthalene (PAHs); dibenzofuran and 2,4-dimethylphenol (non-PAH SVOCs); benzene (aromatic VOC); TCE (chlorinated VOC); arsenic, lead, iron and ammonia (inorganics). The relevant fate and transport characteristics of pesticides and PCB Aroclors also are discussed.

### 5.2.1 Polycyclic Aromatic Hydrocarbons

The nature and extent of PAHs observed at the Site is discussed in detail in Section 4 of this report. PAHs are present at the Site primarily as a result of former operations and the presence of fill material. Historical operations at the former Lever Brothers property also have contributed to the presence of PAHs in portions of the Site, as discussed in Section 4. The characteristics of the representative PAHs, benzo(a)pyrene and naphthalene, are discussed in more detail below since they represent the heavy-end and light-end PAHs, respectively.

In general, PAHs have low water solubility and could adsorb increasingly to soil or particles within groundwater if increasing amounts of organic carbon were in the soil. The less organic carbon found in the soil system, the more mobile the PAH compounds will be. In general, heavy-end PAHs such as benzo(a)pyrene, will adsorb more strongly to soil than the lighter-end PAHs, such as naphthalene. Sorption to soil particles is the primary process responsible for the removal of PAHs from aqueous systems. The effect of sorption generally increases as the number of benzene rings in the PAH-molecule increases. The Koc values for the high-molecular-weight PAHs (greater number of benzene rings) range from  $3.98 \times 10^5$  cm<sup>3</sup>/g (such as benzo(a)anthracene and chrysene) and  $3.8 \times 10^6$  cm<sup>3</sup>/g (such as



dibenzo(a,h)anthracene), which indicates a strong tendency to adsorb to organic carbon present in soil (ATSDR, 2007). The lighter PAHs have lower K<sub>oc</sub> values ranging from  $9.47 \times 10^2$  cm<sup>3</sup>/g (such as acenaphthylene) to  $1.07 \times 10^5$  cm<sup>3</sup>/g (such as fluoranthene), and, although they still have a strong capacity to adsorb, their tendency to do so is less than that of the heavier-end PAHs. Sorption of PAHs to soil and sediment is also directly dependent on particle size. Smaller particles with higher surface-area-to-volume ratios are more efficient at adsorbing PAHs. Sorption has been correlated with bioconcentration in aqueous organisms. Volatilization from soil could be significant for low-molecular-weight PAHs but not for higher-weight PAHs.

Biodegradation of PAHs is well documented and likely is the ultimate fate of these constituents at the Site. Biodegradation of many constituents of coal tar has been demonstrated to occur aerobically and anaerobically, although aerobic degradation pathways are far more efficient, and anaerobic degradation tends to be slower (Bakermans et al., 2002; Johnsen et al., 2005).

The rate of degradation of PAHs is due to several factors, such as NAPL dissolution, aqueous solubility, availability of nutrients, bioavailability of PAHs (sorption to particles), temperature, oxygen, PAH aging, the presence of dissolved organic carbon, and the presence of PAH-degrading microorganisms (Bouwer et al., 1997; Ramboll et al., 2001; Lundstedt, 2003; Johnsen et al., 2005).

Some PAHs degrade most readily at moderate temperatures (20°C); whereas, others such as naphthalene and methylnaphthalene are unaffected by low temperatures (Eriksson et al., 2003).

Biodegradation of naphthalene and pyrene in groundwater has been determined to be greatest in soils with decreased particle size and increased organic matter (e.g., clay). This is believed to be due, in part, to fine-grained soils tending to have lower carbon-to-nitrogen ratios and relatively high nitrogen content (Owabor and Ogunbor, 2007).

Microbial degradation of PAHs and other hydrophobic substrates also is believed to be limited by the amounts of PAHs in the aqueous phase; adsorbed PAHs or PAHs in NAPL are unavailable to PAH-degrading organisms (Lundstedt, 2003; Johnsen et al., 2005). The mobility of PAHs in soils is influenced by the presence of dissolved organic matter. Overall, biodegradation of PAHs at coal-tar sites is limited by dissolution rates of PAHs into groundwater. For example, biodegradation rates of chrysene are slower than for acenaphthene and phenanthrene due to the lower dissolution rates (Kose et al., 2003).

Degradation of PAHs by various indigenous microorganisms at coal-tar sites has been reported (Wilson et al., 1999). Four-ring PAHs, such as fluoranthene, pyrene, chrysene, and benzo(a)anthracenes have been shown to degrade in a variety of bacteria (Kanaly and Harayama, 2000). Pyrene has been shown to degrade biologically at creosote and coal-tar sites through the detection of its metabolites (Kimball et al., 1997; Wilson et al., 1999; Bakermans et al., 2002; Johnsen et al., 2005). At the Glen Falls MGP site in New York, naphthalene-degrading bacteria, capable of mineralizing PAHs, have been demonstrated to be present in source vadose zone and saturated groundwater, and in abundance in the shallow water table downgradient of the removed coal-tar deposits (Ghiorse et al., 1995;

Bakermans et al., 2002). This information suggests the perseverance of degrading bacteria at the edges of highly organic PAH groundwater plumes.

A study of 44 coal-tar sites revealed naphthalene and benzo(a)pyrene concentrations ranging from 11,000 to 19,000 µg/L and from 140 to 289 µg/L, respectively, in groundwater within source areas. The concentrations found in groundwater 10 to 50 meters downgradient of the source areas were significantly lower. For instance, in 90 percent of the samples, the concentrations of naphthalene and benzo(a)pyrene were 630 µg/L and 5 µg/L, respectively. Naphthalene and benzo(a)pyrene were not detected in half the samples taken more than 50 m away from the source area. The 44 coal-tar sites studied were not under active remediation, and the findings are indicative of natural attenuation processes (e.g., volatilization, dispersion, and biological degradation) (Ramboll et al., 2001).

### **Benzo(a)pyrene**

Benzo(a)pyrene releases to the environment are widespread because it is a ubiquitous product of incomplete combustion. Benzo(a)pyrene largely is associated with particulate matter and is often found adsorbed to soil and sediment. Although environmental concentrations are highest near sources, its presence in places distant from former operations indicates that benzo(a)pyrene is reasonably stable in the atmosphere and capable of long-distance atmospheric transport. When released to air, benzo(a)pyrene could be subject to direct photolysis, although adsorption to particulates apparently can retard this process (Spectrum Laboratories Inc., 2007).

When released to soil, benzo(a)pyrene would be expected to adsorb very strongly to soil particles and not to leach appreciably to the groundwater. Benzo(a)pyrene is relatively insoluble ( $1.62 \times 10^{-3}$  mg/L), although its presence in groundwater near sources of NAPL and impacted soil illustrate that it will dissolve somewhat and can be transported over relatively short distances in the dissolved phase. Benzo(a)pyrene is not expected to hydrolyze or significantly evaporate from soil and other organic surfaces. Benzo(a)pyrene could be subject to appreciable biodegradation in soil. Volatilization of benzo(a)pyrene from soil and groundwater does not occur significantly (Spectrum Laboratory, 2007).

### **Naphthalene**

The bulk of naphthalene releases to the atmosphere occurs as emissions and exhaust from the combustion of fuel oil and gasoline. Naphthalene in the atmosphere rapidly photodegrades. Discharges of naphthalene to land and groundwater can occur as spills during the storage, transport, and disposal of fuel oil, coal tar, and other petroleum products.

The sorption of naphthalene to soil will be low to moderate, depending on the organic carbon content of the soil, and leaching to groundwater can occur. Although relatively insoluble, naphthalene is the most soluble of the PAH compounds ( $3.01 \times 10^{-1}$  mg/L) and can be dissolved in groundwater and transported over relatively short distances. The *K<sub>h</sub>* value for naphthalene is  $4.8 \times 10^{-4}$  atm-m<sup>3</sup>/M, indicating that naphthalene is not volatilized readily from soil and shallow groundwater (Spectrum Laboratories, Inc., 2007).

Naphthalene will undergo biodegradation in soil at rates varying greatly, depending on site conditions. When present in groundwater, biodegradation of naphthalene might occur under aerobic conditions. In addition, photolysis, volatilization, biodegradation, and

adsorption could be important mechanisms for the reduction of dissolved-phase concentrations of naphthalene in groundwater. The principal loss processes will depend on local conditions, but half-lives can be expected to range from several days to a few months. Bioaccumulation of naphthalene can occur to a moderate extent (Spectrum Laboratories, Inc., 2007).

### 5.2.2 Non-PAH SVOCs

Non-PAH SVOCs are generally present at the Site as a result of historical operations. Historical operations at the former Lever Brothers property also have contributed to the presence of non-PAH SVOCs in portions of the Site, as discussed in Section 4. The nature and extent of non-PAH SVOCs are fully discussed in Section 4 of this report. Representative compounds are discussed below.

#### Dibenzofuran

Dibenzofuran is released to the environment in atmospheric emissions associated with the combustion of coal, biomass, refuse, and diesel fuel. Wastewater emissions containing dibenzofuran can occur from coal tar, coal gasification, and shale-oil operations. Dibenzofuran is present at the Site presumably as a result of former Site operations. Historical operations at the former Lever Brothers property also have contributed to the presence of dibenzofuran in portions of the Site, as discussed in Section 4.

The estimated *K<sub>oc</sub>* value for dibenzofuran indicates a low to moderate mobility in soil, depending on the organic carbon content. The solubility of dibenzofuran in water is low (3.1 mg/L). When present in the water column in the dissolved phase, the volatilization of dibenzofuran is limited by its low *K<sub>h</sub>* value ( $1.3 \times 10^{-4}$  atm·m<sup>3</sup>/M) and will not volatilize readily from soil or groundwater.

Dibenzofuran will biodegrade readily in aerobic environments with slower degradation rates in anaerobic environments. Abiotic degradation of dibenzofuran in soil or water is not likely to occur. In the atmosphere, dibenzofuran will exist primarily in the gas phase, where it will degrade rapidly by reaction with photochemically produced hydroxyl radicals. Dibenzofuran can bioaccumulate significantly (Spectrum Laboratories, Inc., 2007).

#### 2,4-Dimethylphenol

2,4-Dimethylphenol is known to have been released to the environment as fugitive emissions and in wastewater as a result of coal-tar refining, coal processing, and manufacturing uses for chemicals/plastics. In its pure state, it is a colorless crystalline solid. 2,4-Dimethylphenol is present at the Site presumably as a result of former coal-tar operations. Historical operations at the former Lever Brothers property also have contributed to the presence of 2,4-dimethylphenol in portions of the Site, as discussed in Section 4.

2,4-Dimethylphenol has a low to moderate affinity for adsorption and, thus, will have some mobility in soil. The solubility of 2,4-dimethylphenol in water is moderate ( $7.87 \times 10^{+3}$  mg/L); however, due to its relatively higher solubility compared to other compounds present in soil and NAPL at the Site, 2,4-dimethylphenol would be one of the first SVOCs to dissolve from NAPL at the Site as a result of its higher effective solubility. The effects of this

mechanism (Raoult's Law) on NAPL dissolution is evidenced in the absence of 2,4-dimethylphenol in NAPL samples at the Site, where 2,4-dimethylphenol was detected in only one sample (MW-105) at a low concentration (106 J mg/kg). The absence of this compound and other compounds of higher solubility, including other phenolics in addition to their presence in soil and groundwater, suggests that these compounds were once a component of the NAPLs but since then have been preferentially dissolved from the NAPLs and remain only sorbed to soil and dissolved in groundwater. The removal of these compounds from the NAPL through dissolution would be anticipated to be a very slow process, and these data suggest that NAPLs at the Site have been subject to dissolution for an extended period. The  $Kh$  value for 2,4-dimethylphenol is  $2.0 \times 10^{-6}$  atm-m<sup>3</sup>/M, which indicates that it is nonvolatile and will not migrate readily from soil and shallow groundwater in the vapor phase.

When released in water, 2,4-dimethylphenol will degrade principally due to biodegradation with a half-life of hours to days at ambient temperature. In humic waters, oxidation by alkyl peroxy radicals could be important. Adsorption to soils and particulate matter is moderate. 2,4-Dimethylphenol adsorbs moderately to soils and biodegrades in several days (Spectrum Laboratories, Inc., 2007).

### 5.2.3 Aromatic VOCs

Aromatic VOCs are present at the Site presumably as a result of the former operations. Historical operations at the former Lever Brothers property also have contributed to their presence in portions of the Site, as discussed in Section 4. The nature and extent of aromatic VOCs are discussed fully in Section 4. Benzene is the most widely distributed and representative aromatic VOC at the Site.

In its pure form, benzene is a colorless liquid with a sweet odor. It is widely used in the United States and ranks in the top 20 chemicals for production volume. Benzene is found in coal tar, crude oil, gasoline, and cigarette smoke. Benzene is used to make lubricants and dyes and to make other chemicals that, in turn, are used to make compounds such as plastics and resins. Natural sources of benzene include volcanoes and forest fires. Benzene can enter the atmosphere from fugitive emissions and exhaust connected with its use in gasoline. Another important source is emissions associated with its production and use as an industrial intermediate. Benzene is highly flammable.

Benzene has a low affinity for adsorption and will leach readily from soil to groundwater. With a solubility of  $1.75 \times 10^{-3}$  mg/L, it dissolves slightly in water. Benzene will biodegrade in aerobic and anaerobic groundwater and soil systems. With a  $Kh$  value of  $5.56 \times 10^{-3}$  atm-m<sup>3</sup>/M, benzene readily can volatilize from shallow soil and groundwater. Benzene will react with other chemicals in the air and breaks down within a few days. Benzene in air can attach to precipitation and return to the ground surface. Benzene does not bioaccumulate (Spectrum Laboratories, Inc., 2007).

### 5.2.4 Chlorinated VOCs

Chlorinated VOCs (primarily TCE and its daughter compounds) are present at the Site primarily as a result of an upgradient source or sources of solvents as discussed in Section 4. The nature and extent of chlorinated VOCs are discussed fully in Section 4.

Trichloroethylene is a nonflammable and colorless liquid. TCE is used mainly as a solvent to remove grease from metal parts, but it is also an ingredient in adhesives, paint removers, typewriter correction fluids, and spot removers. TCE does not occur naturally in the environment.

Trichloroethylene is slightly soluble in water ( $1.1 \times 10^{-3}$  mg/L), and can persist in soil and groundwater. TCE has a low affinity for adsorption and will leach readily from soil to groundwater. With a  $K_h$  value of  $1.03 \times 10^{-2}$  atm-m<sup>3</sup>/M, TCE is highly volatile and will volatilize readily from shallow soil and groundwater. TCE commonly is found as a vapor in the air, but TCE does not bioaccumulate significantly in plants and animals (Spectrum Laboratories, Inc., 2007).

Trichloroethylene, as well as other chlorinated solvents, has been extensively documented to biodegrade under aerobic and anaerobic conditions that can involve their use as an electron acceptor (reductive dechlorination) or donor, or break down through co-metabolism (EPA, 1998c). These microbially mediated processes will result in the generation of breakdown products such as cis-1,2-DCE, vinyl chloride, and eventually ethene. The increased presence of carbon sources such as native organics, regional fill material, and hydrocarbons associated with fuel or coal tar will enhance the microbial processes necessary for reductive dechlorination to occur (EPA, 1998c).

### 5.2.5 Inorganics

The nature and extent of inorganics are discussed more fully in Section 4. Inorganic constituents exceeding their applicable soil-screening criteria consisted solely of certain metals (Table 4-6), while inorganic constituents exceeding their applicable groundwater criteria consisted of a metal (lead), a metalloid (arsenic) and ammonia (Table 4-8). As discussed in Section 4, there are two distinct sources of metals and metalloid at the Site: the former acid plant and regional fill material. On the other hand, ammonia was stored at the Site during historical coal-tar operations, but the distribution systems (i.e., piping systems) for ammonia and its potential use in manufacturing are not known.

#### Arsenic

Arsenic is a naturally occurring metalloid widely distributed in the earth's crust. In the environment, arsenic is combined with oxygen and sulfur to form inorganic arsenic compounds. Arsenic in animals and plants combines with carbon and hydrogen to form organic arsenic compounds.

Arsenic is present under environmental conditions dominantly in either the oxidized +5 (arsenate) or reduced +3 (arsenite) valence states as anions (negatively charged ions). Arsenic also could exist in the As<sup>-3</sup> and As<sup>0</sup> states but only under highly reducing conditions. Arsenic can undergo transformation between valence states (e.g., through redox or microbial processes). It can be adsorbed onto soil, washed away by surface runoff, or leached into groundwater. Precipitation will remove arsenic dust particles from the air. Arsenic can bioaccumulate in plants and animals. Arsenic in soil could enter the air, water, and land from wind-blown dust and can leach to lower soil horizons and groundwater. Arsenic is not water soluble, but many of its compounds are water soluble (ASTDR, 2007).

Arsenic as a free element (0-oxidation state) is rarely encountered. Soluble inorganic arsenate (+5-oxidation state) predominates under normal oxidized conditions because it is thermodynamically more stable in water than arsenite (+3-oxidation state). Both are weak acids. Most of the arsenic in water ultimately will end up adsorbed to soil particles or sediment. Arsenic and most of its compounds are solids that do not evaporate. They can exist as small particles in the atmosphere. Burnt arsenic compounds can exist as a gas that has either volatilized into the atmosphere or condensed in shallow soils (ASTDR, 2007).

In saturated soils, the mobility and fate of arsenic are affected largely by its adsorption to organic matter and mineral sites, as well as its incorporation into certain minerals. Because the anionic form of arsenic will dominate in saturated soils, the presence of strong anion adsorbers, such as ferric iron in the form of iron oxyhydroxides have the greatest impact on their mobility. If iron oxyhydroxides are not present (a very unusual condition), clay minerals will provide the most important sorption exchange sites, which tend to retard their movement in saturated soil conditions. The mobility of arsenic is dependent mainly upon pH and redox conditions, which can preclude the formation of iron oxyhydroxides and can change the redox state of arsenic such that it is less readily adsorbed. Arsenic attenuation by iron oxyhydroxides increases as the pH decreases to values less than about 7 and decreases with pH values above about 7. Conditions that are less oxidizing will enable the migration of iron oxyhydroxides; whereas, oxidizing conditions tend to retard their mobility (Deutsch, 1997). The effects of groundwater geochemistry on arsenic mobility at the Site are discussed in detail in Section 5.5.3.

## **Lead**

Lead is a constituent of many minerals and is a commonly detected element in soils and sediments. Lead is also used historically in many manmade products, including fuels, paints, and batteries. Naturally occurring lead in soil is often strongly adsorbed to sediments, particularly to fine-grained material containing clay. Generally, lead compounds are insoluble and do not tend to be mobile in aquatic environments.

Lead itself does not break down, but lead compounds are changed by sunlight, air, and water. Most lead is retained strongly in soil and very little is transported into surface water or groundwater (NSF, 1977). Clays, silts, iron and manganese oxides, and organic matter in soil can bind metals electrostatically (adsorption) and chemically (Reed et al., 1995). Sorption of lead to iron oxyhydroxides and precipitation during the formation of carbonate minerals are the primary fixation processes for lead, with sorption to organic matter in soil serving as a secondary fixation mechanism. With the exception of highly acidic environments, these mechanisms limit the movement of lead in water and the downward movement of elemental lead and inorganic lead compounds from soil to groundwater by leaching is very slow under most natural conditions (NSF, 1977).

Although lead itself is not a redox-sensitive metal, its mobility can be affected by the redox state of the system because adsorption sites and mineral formations key to immobilizing lead can be affected by changes in redox potentials and pH. Being a cation (positively charged ion) in water, it is attenuated by iron oxyhydroxide at pH values less than about 7 but is increasingly attenuated at pH values greater than about 7. In general, lead is considered one of the least mobile metals commonly found as contaminants (Deutsch, 1997).

## Ammonia

The presence of ammonia in groundwater at the Site is likely a result of storing ammonia at the Site as part of the historical operations, as well as a result of natural processes. Ammonia is an important nutrient needed by plants and animals. Ammonia is applied directly into soil on farm fields and is used to make fertilizers for farm crops, lawns, and plants. Many household and industrial cleaners contain ammonia. Ammonia is a colorless gas with a very distinct odor.

Ammonia is found throughout the environment in air, water, soil, animals, and plants. Ammonia does not persist in the environment and does not build up in the food chain but serves as a nutrient for plants and bacteria. It is rapidly taken up by plants, bacteria, and animals as part of their metabolic processes. Ammonia gas can be dissolved in water in its un-ionized state or as the ammonium ion. Exposed to open air, un-ionized ammonia can quickly vaporize.

The fate of ammonia in subsurface soils is controlled primarily by soil cation exchange reactions; ammonium ( $\text{NH}_4^+$ ) is relatively strongly held on the clay mineral exchange sites. Ammonium can be oxidized to nitrite ( $\text{NO}_2^-$ ) and then to nitrate ( $\text{NO}_3^-$ ) under aerobic groundwater conditions (Deutsch, 1997).

### 5.2.6 Pesticides

The presence of pesticides at the Site is likely the result of the historical use of pesticides at the Site and adjacent properties. The nature and extent of pesticides are fully discussed in Section 4 of this report. The general concepts of fate and transport of pesticides that have been detected at the Site are presented below.

When released to soil, the pesticides found at the Site would be expected to adsorb very strongly to soil particles and not to appreciably leach to the groundwater. With solubilities ranging between  $9.0 \times 10^{-2}$  and  $2.0 \text{ mg/L}$ , these compounds are relatively insoluble, which explains their limited and localized presence in groundwater at the Site. Pesticides observed at the Site can biodegrade in soil and water, and degradation rates generally will be more favorable under anaerobic conditions. Hydrolysis can be an important factor in the degradation of certain pesticides, such as heptachlor, in moist soils and groundwater. The half-lives of pesticides are quite variable and range from several days to several years. Pesticides can bioaccumulate in the environment, and they tend to persist in both fresh water and saltwater for long periods of time. With  $K_h$  values ranging between  $1.09 \times 10^{-3}$  (heptachlor) and  $4.0 \times 10^{-6} \text{ atm-m}^3/\text{M}$  (4,4'-DDE), volatilization of pesticides detected at the Site from shallow soil and groundwater is not anticipated to occur in any significance.

### 5.2.7 Polychlorinated Biphenyls

Polychlorinated biphenyls are present in shallow soil at the Site as a result of former Site operations. Historical operations at the former Celotex property and the former Lever Brothers property also have contributed to the presence of PCBs in portions of the Site, as discussed in Section 4. NAPL samples tested from the Site did not contain PCBs. PCB contamination at the Site is minor compared to other COIs. PCBs at the Site were detected in less than 25 percent of soil samples and only were detected in one groundwater sample at

an offsite monitoring well (MW-J) where the concentration exceeded screening criteria. The nature and extent of PCBs are fully discussed in Section 4.

PCB Aroclors are mixtures of up to 209 individual chlorinated compounds (known as congeners). No natural PCBs are known to exist. PCBs are oily liquids or solids that are colorless to light yellow. Some PCBs can exist as a vapor in air. PCBs have no known smell or taste. Many commercial PCB mixtures are known in the United States by the trade name Aroclor. PCBs have been used as coolants and lubricants in transformers, capacitors, and other electrical equipment because they do not burn easily and are good insulators. The manufacture of PCBs ceased in the United States in 1977 because of evidence that they accumulate in the environment and might have adverse health effects.

Aroclors 1254 and 1260 were by far the most common of the Aroclors detected in soil at the Site and behave very similarly in the environment. PCBs do not break down readily in the environment. In general, the persistence of individual PCB congeners or Aroclor mixtures increases with an increase in the degree of chlorination. Although biodegradation of PCBs in soil and water might occur very slowly on an environmental basis, no other degradation mechanisms have been shown to be significant; therefore, biodegradation might be a significant factor in the degradation process.

Polychlorinated biphenyls are strongly sorbed to soil, with greater sorption in the presence of organic carbon and with an increase in the degree of chlorination of the individual congeners. As a result, PCBs are strongly attenuated in most soils unless organic solvents are available. The solubility in water of PCB Aroclors detected at the Site is quite low, ranging between  $5.7 \times 10^{-2}$  and  $3.4 \times 10^{-1}$  mg/L. In the absence of a significant source, PCB Aroclors are rarely found in groundwater in the dissolved phase. In water, a small amount of PCBs might remain dissolved, but they adsorb more often to organic particles and bottom sediments. With low  $K_h$  values, the volatilization of PCBs is expected to slow. However, due to their relative persistence in the environment, the long-term effects of volatilization might be an important factor in their eventual removal from shallow soil and groundwater. PCBs have been shown to bioaccumulate significantly (Spectrum Laboratories, 2007).

Polychlorinated biphenyls can be present in the atmosphere where they can travel long distances sorbed to particulate matter. Physical processes are more important than chemical transformation in air, and removal from the atmosphere is accomplished by wet and dry depositional processes.

### **5.3 Fate and Transport of Non-Aqueous Phase Liquid**

NAPL in the subsurface at the Site could have originated from ASTs or USTs (as shown in Figure 4-1) along with associated piping, and/or from offloading operations from delivery barges. All primary sources of NAPL have been removed from the Site, except for some buried piping on the Quanta property. Secondary sources of NAPL, both as residual immobile product and, in more limited areas, as free-phase liquid (as identified by accumulation within monitoring wells), have been identified at the Quanta and 115 River Road properties, Block 93 (North, Central, and South), the former Celotex property, and the former Lever Brothers property. NAPL also is likely to be present beneath River Road.



As discussed in Section 4.1.1, extensive characterization has revealed that the majority of NAPL at the Site is present as part of four discrete NAPL Zones (NZ-1, -2, -3, and -4). An additional zone (NZ-5) was identified based on its proximity to the Hudson River and the need to evaluate these impacts for the purpose of the remedy selection process. The NAPL zones are depicted in Figure 4-4 and described as follows:

- **NZ-1:** Shallow NAPL located primarily in the western/central portion of the Quanta property, 115 River Road, and the northern portions of the former Lever Brothers property between 3 and 11 feet bgs. In the vicinity of the former tar USTs (MW-102B and SB-9), this zone extends to a depth of 24 feet.
- **NZ-2:** Shallow NAPL in the eastern portion of the Quanta property adjacent to the wooden bulkhead between 3 and 14 feet bgs.
- **NZ-3:** Deeper NAPL in the southern central portion of the Quanta property, portions of 115 River Road, and northern portions of the former Lever Brothers property; present between 15 and 25 feet bgs.
- **NZ-4:** Shallow and deeper NAPL beneath Block 93 Central, Block 93 South, River Road, and the northwestern portion of the former Lever Brothers property; present in two separate layers: between 10 and 15 feet and between approximately 20 and 30 feet bgs.
- **NZ-5:** Deeper NAPL in the southeastern corner of the former Celotex property adjacent to the Hudson River between 18 and 25 feet bgs

The discontinuous nature of NAPL in the subsurface at the Site and the varying physical characteristics (e.g., viscosities, densities, and interfacial tensions) of NAPL samples collected across these areas suggest that individual forms will vary in their ability to migrate. The following discussion addresses the fate and transport processes that affect the NAPL present within each NAPL Zone and the degree to which this material is mobile under current conditions.

The characterization of the current mobility of the NAPL material within each zone will have a significant impact on the potential recoverability of this material in the future (i.e., during remedy implementation). The potential recoverability has, to some extent, been demonstrated by NAPL product recovery tests conducted in December 2006 and July 2007 and is discussed in the November 6, 2007, "NAPL Recovery Testing Results Technical Memorandum" (CH2M HILL, 2007).

The potential for altering subsurface conditions that play a role in NAPL mobility is an important consideration for the Site. The effects of future development activities, such as excavation or placement of fill material, placement of subsurface structures, or pumping of groundwater should be considered when specific development plans have been defined.

### 5.3.1 NAPL Zone 1

NZ-1 consists primarily of two areas of shallow NAPL impacts (NZ-1A and NZ-1B) located generally between 3 and 11 feet bgs in the western and central portions of the Quanta property, 115 River Road, and the northern portion of the former Lever Brothers property. Most of the NAPL in NZ-1A (Figure 4-4) is in the southwest corner of the Quanta property in the vicinity of the MW-102 and MW-112 series monitoring wells; it has not migrated

downward more than 8 feet below the water table (total depth of approximately 11 feet bgs) and has not reached the depth of the top of the silty-clay confining unit (approximately 20 feet bgs in this area), except for an isolated area in the vicinity of former tar USTs (i.e., MW-102B and SB-9). This is likely the result of the elevated viscosities and interfacial tensions of this NAPL as well as the presence of peat layers, which have combined to prevent further downward migration. At MW-102B and SB-9, further migration is prevented by the presence of the silty-clay confining unit.

NAPL within NZ-1B is at a similar interval as that in NZ-1A (Figure 4-4) but is located farther to the east, in the central portion of the Quanta property, and extends to the south onto the northern portion of the former Lever Brothers property. NAPL in this zone is underlain by the deeper NAPL associated with NZ-3. Unlike that in NZ-3, which is a lower-viscosity NAPL (as measured in a sample collected from MW-107), the NAPL observed at NZ-1B (MW-103) has been described in the field as medium to high viscosity, and as a result has not migrated downward as far as the top of the silty-clay confining unit (approximately 20–25 feet bgs in this area)

Considering the age of the release (minimum of 36 years), if the NAPL in NZ-1 were able to migrate, it likely would encompass significantly greater areas than those observed today. Given its lack of mobility in this zone, further migration of NAPL at NZ-1 is not predicted to occur under current conditions.

### **5.3.2 NAPL Zone 2**

NZ-2 consists of shallow NAPL in the eastern portion of the Quanta property adjacent to the wooden bulkhead between 3 and 14 feet bgs. Again, high viscosities and interfacial tensions were measured in NAPL samples collected from monitoring wells screened within NZ-2 and throughout the entire zone. The physical properties of the NAPL here appear to be generally sufficient to prevent further migration under current conditions. Further work is being performed to characterize the deeper discrete NAPL interval observed below NZ-2 at MW-116DS at a depth of 24 to 25 feet bgs. Additional soil borings will help refine the extent of this deeper NAPL and determine whether it is contiguous with NZ-2 and/or NZ-5. Groundwater elevation measurements consistently have demonstrated that the wooden bulkhead serves as a significant hydraulic barrier between OU1 and OU2 and thus will serve as a barrier to more viscous fluids, such as NAPL. This fact provides further indication that NAPL is not likely migrating from NZ-2 to OU2 through the bulkhead.

However, in light of remaining uncertainty in this area, particularly with regard to the deeper NAPL observed at MW-116DS and the unknown vertical extent of the wooden bulkhead, additional investigation at NZ-2 has been proposed as part of the SRI.

### **5.3.3 NAPL Zone 3**

NZ-3 consists of deeper NAPL in the central portion of the Quanta property, extending across the 115 River Road property onto the northern portion of the former Lever Brothers property. This layer begins at a depth of approximately 15 feet bgs and extends to the top of the silty-clay confining unit at approximately 25 feet bgs. Both the viscosity and interfacial tension of the NAPL sample collected from this zone (MW-107) were lower than those measured in samples collected elsewhere at the Site. The NAPL here has migrated

downward and laterally until reaching a natural depression in the top of the silty clay confining unit. The undulating surface of the silty-clay confining unit has been extensively mapped as part of the RI investigations for OU1 and is depicted in Figure 3-4b. The silty-clay layer has been found to slope upward toward the Hudson River and to the south (Figures 4-2 and 4-3). As a result of gravitational forces, NAPL at NZ-3 cannot move beyond the natural depression and, despite the hydraulic forces pushing groundwater to the south, it does not appear to be migrating either laterally or deeper under current conditions. The impermeability of the confining layer prevents downward vertical migration at the upper surface of this layer.

#### **5.3.4 NAPL Zone 4**

NZ-4 comprises shallow and deeper NAPL beneath Block 93 Central, Block 93 South, River Road, and the northwestern portion of the former Lever Brothers property. NAPL at NZ-4 has not been fully delineated; however, an RI/FS Work Plan Addendum (CH2M HILL, 2008a) has been submitted proposing the completion of this delineation. NAPL observed at NZ-4 was described during fieldwork as having low to medium viscosity and as existing in two separate layers between 10 and 15 feet and approximately 20 and 30 feet bgs. Potential migration of NAPL in NZ-4 will be determined through the completion of the proposed additional delineation work in this area.

#### **5.3.5 NAPL Zone 5**

Analysis of boring logs from the RI, SI, and work performed by EWMA (2003, 2004a) and Environ (2005, 2006a, b, 2007) indicate that NAPL was identified as far as 150 feet north of and along the southeastern border of the former Celotex property. NAPL was identified in borings and by TarGOST® adjacent to the Hudson River between 18 and 25 feet bgs, and farther west on the former Celotex property. Cross-section B-B' in Figure 5-5 presents coal tar distribution in this area and in OU2, showing a vertical displacement of approximately 5 feet between NAPL at OU1 and NAPL at OU2. For the purpose of the remedial alternatives development, evaluations, and selection, it is presently conservatively being assumed that the potential for NAPL migration exists between OU1 and OU2 in the area of NZ-5. In order to determine if there is a relationship between NZ-5 and NZ-2 and to address questions regarding the mobility of NAPL at NZ-5 relative to OU2, data collection has been proposed as part of the SRI.

#### **5.3.6 Summary of NAPL Fate and Transport**

There are five discrete key NAPL zones that have been identified at the Site. Although some limited pockets of residual or free-phase NAPL are present outside the defined NAPL zones (Figure 4-4), most of the NAPL at OU1 is located within these zones. Since most NAPL at OU1 is denser than water, the NAPL has migrated downward under the force of gravity but is retained, either by its elevated viscosity and interfacial tensions and increasing pore pressure with depth, or by the presence of the silty-clay confining layer. NAPL identified at depth has been found to accumulate in the natural depressions in the surface of the confining unit and due to gravitational forces and the presence of upward sloping surfaces of the silty-clay confining unit to the south and east, these NAPLs are not mobile. Therefore, in NAPL Zones 1, 3, and 4, further migration of NAPL is not predicted to occur. Additional work has been proposed in the area along the shoreline in the vicinity of NZ-2 and NZ-5 as

part of the SRI in order to address the uncertainties regarding the fate and transport of NAPL to OU2. Due to the proximity of the NAPL to the Hudson River, the remedial alternative development, evaluation, and selection will conservatively assume that the potential for NAPL migration between OU1 and OU2 should be addressed at NZ-2 and NZ-5.

### **5.3.7 Tar Boils**

Tar boils on parts of the Quanta Site are a potential source of NAPL transport. The general extent of where tar boils have been observed at the Site is depicted on Figure 4-4.

The tar boils occur during the summer months when solid, taffylike tar in the near subsurface vadose zone is heated by the sun and/or ambient air temperatures, and seeps through surface cracks in soil or pavement. A visual "boil," or bubbling, of the material has been observed only on very hot days (at or around 90°F) at the Site. Once the tar reaches the surface, it either forms a bubble or spreads out laterally in thin layers within the preexisting, hardened tar (from past heating events). The lateral extent of the boils is generally less than 10 feet along their longest axis and under 1 inch thick. The tar boils have been observed only as discontinuous entities at the Quanta property and have not been observed on any of the other properties included in the Site.

Tar boil materials and their constituents are generally defined as highly viscose liquid that are solid at room temperature and consist of a complex mixture of hydrocarbons and heterocyclic compounds. Coal tar and creosotes are dominated by PAHs (typically around 85 percent PAHs). These compounds have low aqueous solubilities and high interfacial tensions.

Once the tar has reached the surface as a result of heating, volatilization of the tar's lighter-end components typically occurs. Dissolution of the tar's constituents may also occur as a result of exposure to rain water; however, because of the insolubility of its components this mechanism is expected to be minimal. Dissolved constituent impacts in surface water will be subject to further volatilization and adsorption to surface soils as rain water evaporates or percolates through the subsurface. Transport to Hudson River via rainwater exposure and subsequent runoff is not expected to be significant.

Although the tar boils represent a mechanism for coal tar in shallow soil to be transported to the ground surface, they do not constitute a major mechanism for the transport of NAPL or its constituents beyond the limited areas where they are observed. The tar boils observed at the Site represent a localized mechanism for upward transport of NAPL onto the surface. Beyond localized surface exposure, the boils do not measurably contribute to the overall lateral or vertical movement of Site constituents in either soil or groundwater at the Site.

## **5.4 Soil Fate and Transport**

There are two major mechanisms for the transport of COIs in soil at the Site; leaching and volatilization. The effect of these mechanisms on the various classes of constituents in soil at OU1 is described below. Wind and water erosion of surface soil is insignificant because most areas of OU1 are covered with buildings, asphalt, concrete, vegetation, gravel, or standing water, all of which help control stormwater erosion, prevent fugitive dust

emissions and most of which limit surface water infiltration through subsurface materials into the groundwater system. Degradation and bioaccumulation play less significant roles in the transport of COIs at the Site.

Infiltration of water into the unsaturated zone is limited in most areas of OU1 by buildings, asphalt, concrete or the impermeable liner in high arsenic area, limiting the amount of pore water available for dissolution and subsequent transport from unsaturated to saturated soils. Leaching can also occur within the capillary-fringe of the unsaturated zone as a result of fluctuations in the water table and increased soil moisture content. However, the majority of leaching will occur within the saturated zone where COIs in soil and NAPL are present, as described in Section 5.5.

Constituents of interest at OU1 that are in NAPL or are sorbed to soil particles are generally unavailable to microorganisms until they are dissolved in groundwater, thus biodegradation of COIs in unsaturated or saturated soil is not expected to be a significant loss mechanism at OU1. COIs in saturated soil could leach at highly variable rates into groundwater and thereby become available for degradation, as described in Section 5.5.

Semivolatile organic compounds and VOCs generally do not bioaccumulate; however, inorganic constituents, pesticides, and PCBs will bioaccumulate. The absence of aquatic life at OU1 diminishes the importance of bioaccumulation. The plants and trees at the Quanta property might be bioaccumulating constituents; however, the plants and trees most likely would be removed during any remedial actions at the Site and do not represent a significant migration pathway.

#### 5.4.1 Polycyclic Aromatic Hydrocarbons

The effects of leaching and volatilization on the fate and transport of PAHs varies by constituent. Because of the observed distribution of benzo(a)pyrene and naphthalene at the Site, these constituents have been considered in greater detail.

The presence of benzo(a)pyrene and naphthalene in groundwater at the Site is attributable to a combination of leaching from NAPL, and to a lesser degree, leaching by infiltration from the unsaturated soils and leaching of constituents from saturated soils, over the past 25 to 130 years. As predicted by high *K<sub>oc</sub>* values and the limited amount of surface area available for infiltration, PAHs at OU1, such as benzo(a)pyrene, strongly adsorb to soil particles and do not appreciably volatilize or leach to the groundwater. Benzo(a)pyrene isoconcentration contours between the unsaturated (Figure 4-9) and saturated (Figure 4-10) soil for benzo(a)pyrene are fairly similar as this COI in unsaturated soil has not been depleted through volatilization or leaching. Lateral transport in soil through leaching in the saturated zone does not appear to occur.

Naphthalene exceedances of the screening criterion in saturated soil (Figure 4-12) are more extensive than those observed in unsaturated soil (Figure 4-11). Exceedances in unsaturated soil are limited to the footprint of former Site operations. Because of its lower *K<sub>oc</sub>* naphthalene will less readily be sorbed to soil than benzo(a)pyrene and thus leaching and volatilization is more likely to occur. Leaching and volatilization have resulted in the depletion of naphthalene in unsaturated secondary sources and have resulted in this reduced extent of shallow impacts. The majority of volatilization at the Site has likely already occurred. This is supported by the results of soil vapor sampling which indicate that

volatilization is not currently a significant transport mechanism for PAHs. Additional volatilization of PAHs from surface soil is not expected to continue unless surface soil is disturbed.

### **5.4.2 Non-PAH SVOCs**

Non-PAH SVOCs, similar to PAHs, have a low propensity to leach since they adsorb strongly to soil. However, leaching from soil and NAPL of some SVOCs (such as dibenzofuran, 2,4-dimethylphenol, and carbazole) to the groundwater has occurred at the Site (shown in Figure 4-32). The groundwater concentrations of dibenzofuran, 2,4-dimethylphenol, and carbazole are generally three orders of magnitude less than their individual concentrations in unsaturated soil. The presence of SVOCs in groundwater at the Site is attributable to a combination of leaching by infiltration from the unsaturated soils and leaching of adsorbed constituents by groundwater in the saturated soils over the past 25 to 130 years. Soil vapor sampling conducted during soil vapor intrusion investigations at OU1 indicate that volatilization is not currently a significant transport mechanism for non-PAH SVOCs.

### **5.4.3 Aromatic VOCs**

The presence of aromatic VOCs in groundwater at the Site is attributable to a combination of leaching from NAPL, and to a lesser degree, leaching by infiltration from the unsaturated soils and leaching of constituents from saturated soils, over the past 25 to 130 years. For example, benzene has a low affinity for adsorption and can readily leach and volatilize from shallow soil to groundwater and soil gas, respectively. Leaching and volatilization that has occurred over the past 25 to 130 years has resulted in a relatively small area of benzene in unsaturated soil (Figure 4-17), as compared to saturated soil (Figure 4-18). Concentrations of benzene in groundwater are generally one order of magnitude less than concentrations in soil. Detections of xylenes in groundwater are generally two orders of magnitude less than detections in soil. However, most volatilization at the Site has likely already occurred. This is supported by the results of soil vapor sampling which indicate that volatilization is not currently a significant transport mechanism for aromatic VOCs. Aromatic VOCs in surface soil are not expected to volatilize further unless the surface soil is disturbed.

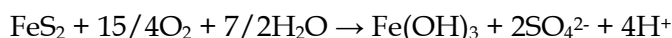
### **5.4.4 Chlorinated VOCs**

Due to their minimal and sporadic localized occurrence at low-level concentrations in soil at the Site, transport of chlorinated VOCs in soil via leaching or volatilization does not appear to be occurring at any measurable scale. Chlorinated solvents at OU1 have been detected primarily in groundwater samples collected from the confined deep sand unit; therefore, volatilization of chlorinated VOCs from groundwater to soil vapor and the repartitioning of these constituents to soil are not anticipated to occur.

### **5.4.5 Metals**

The nature and extent of metals are discussed more fully in Section 4. Two distinct sources of metals are at the Site, that is, the former acid plant and fill material as discussed in Section 4.

Results of the XRD and Thin Section Petrographic analyses show a distinct mineralogical difference between the brown/black fill and the soils within the footprint of the former acid plant, specifically those visually identified by their reddish-purple color. The presence of pyrite and jarosite indicate that the reddish-purple soils include unburned original pyrite or partially burned pyrite that is continuing to oxidize. Exposure of this pyrite ore to rain, moisture, and groundwater results in the oxidation of this material and ultimately produces reddish iron-oxide minerals, as well as elevated concentrations of iron and metal impurities within the pyrite. Impurities within the pyrite frequently include arsenic, lead, copper, antimony, and thallium. The oxidation reaction of pyrite ( $\text{FeS}_2$ ) can be generally expressed as follows:



In the presence of molecular oxygen ( $\text{O}_2$ ) that can be present in the form of rainwater, the Fe(II) and  $\text{S}_2$ (-II) present as pyrite are oxidized by the  $\text{O}_2$  resulting in ferrihydrite ( $\text{Fe}(\text{OH})_3$ ), dissolved sulfate ( $\text{S}(\text{VI}) \text{O}_4^{2-}$ ), and hydrogen ions ( $\text{H}^+$ ). This reaction results in an acidic solution around the oxidizing pyrite grains.

For sources of metals outside the historically documented footprint of the former acid plant associated with the slag-rich fills, the transport of metals in unsaturated and saturated soils is controlled and attenuated by the adsorption of these metals to soil in the presence of infiltrating rain water and groundwater, respectively. SPLP results for samples collected throughout areas of fill indicate that these soils have the capacity to leach antimony, arsenic, copper, iron, and lead at concentrations at or above groundwater screening criteria. Transport of metals in unsaturated fill material as a result of rainwater infiltration is anticipated to be a minor transport mechanism compared to the leaching of metals from these sources within the saturated zone where geochemical conditions favor their dissolution. This is discussed in detail in Section 5.5.3.

Leaching of arsenic in saturated soil and subsequent transport in groundwater is controlled mainly by groundwater redox chemistry, pH, organic carbon content (including NAPL), and the formation of iron oxyhydroxides in oxidizing conditions. This is discussed in detail in Section 5.5.3.

#### 5.4.6 Ammonia

The nature and extent of ammonia is discussed more fully in Section 4. Ammonia was stored at the Site during historical coal-tar operations, but its distribution systems (i.e., piping systems) and potential use in manufacturing are not known.

Ammonia released at the Site, primarily from leaking USTs and/or pipes, was retarded mostly by soil exchange reactions on Site soils, as observed by the soil and groundwater analytical data sets. Its fate and migration is controlled principally by redox chemistry. Under reducing conditions such as those observed in saturated soils in areas with elevated ammonia in groundwater (western portions of the Quanta property), ammonium ( $\text{NH}_4^+$ ) will form and tend to be adsorbed strongly to clay-mineral exchange sites rendering the ammonia relatively immobile. In oxidizing conditions near the ground surface, ammonium is attenuated through the nitrification process oxidizing it to nitrite ( $\text{NO}_2^-$ ) and nitrate ( $\text{NO}_3^-$ ), as well as the generation of nitrogen ( $\text{N}_2$ ) and nitrous oxide ( $\text{N}_2\text{O}$ ) gases (Deutsch, 1997).

### 5.4.7 Pesticides

When released to soil, the pesticides found at the Site will be expected to adsorb strongly to soil particles and not to leach appreciably to groundwater. With solubilities ranging between  $9.0 \times 10^{-2}$  and  $2.0 \text{ mg/L}$ , these compounds are relatively insoluble. Heptachlor was detected at one groundwater location above its applicable groundwater screening criteria. With high  $K_{oc}$  values and  $K_h$  values ranging between  $1.09 \times 10^{-3}$  (heptachlor) and  $4.0 \times 10^{-6} \text{ atm-m}^3/\text{M}$  (4,4'-DDE), leaching and volatilization of pesticides detected at the Site is not anticipated to be measurable.

### 5.4.8 Polychlorinated Biphenyls

Polychlorinated biphenyls exist primarily in unsaturated soil at the Site. PCBs at the Site are sorbed strongly to soil and are not significantly leaching to groundwater. PCBs were detected only once above screening criteria in groundwater, at an offsite monitoring well (MW-J). Because they are strongly sorbed to soil, PCBs are immobile in the subsurface.

With low  $K_h$  values, the volatilization of PCBs is expected to be slow. However, due to their relative persistence in the environment, the long-term effects of volatilization might be an important factor in the eventual removal of PCBs from shallow soil and groundwater (Spectrum Laboratories, 2007).

## 5.5 Fate and Transport of Groundwater

The migration of COIs in groundwater is a function of advective flow, geochemical conditions, and constituent-specific attenuation factors. Attenuation mechanisms in groundwater include degradation, sorption (adsorption and mineral precipitation), dispersion, dilution from recharge, and volatilization. This section will focus primarily on advective groundwater flow and the effects of adsorption, mineral precipitation, and degradation reactions on constituent migration.

As discussed in Section 5.1.2, retardation due to adsorption can significantly slow the rate of migration of dissolved-phase COIs in groundwater. For inorganic constituents such as arsenic, a change in valence state affects the adsorption or coprecipitation mechanisms and can significantly reduce or eliminate arsenic transport in the dissolved phase. At the leading edge of groundwater plumes, degradation and sorption could be sufficient to remove the mass of contaminant at a rate that is equal to or greater than the rate at which the contaminant is dissolving and migrating from the source area thus resulting in a stable or shrinking plume.

Microbial activity and biodegradation are important factors for groundwater contaminant fate and transport at the Site. The reduction of dissolved oxygen within groundwater at the Site, lower Eh values within the interior of the groundwater plumes (Figures 5-1 and 5-2), and the presence of organic nitrogen in groundwater demonstrate that microbial activity and biodegradation are ongoing in groundwater at the Site. The assessment of adsorption and degradation effects for groundwater contaminant transport presented in the following sections focuses on observed Site conditions relative to the established principles governing groundwater fate and transport of representative COIs, and where applicable the



development and presentation of primary lines of evidence indicating the relative stability of contaminant plumes.

Additional data collection has been proposed as part of the SRI to supplement the existing data set and demonstrate that concentrations and plume geometry are stable over time. These results will be presented in the Supplemental RI Report for OU1.

### 5.5.1 Semivolatile Organic Compounds

#### Polychlorinated Aromatic Hydrocarbons

In general, dissolved PAHs are not highly mobile or persistent in groundwater and on the basis of available data, do not appear to be migrating offsite. This is because the high number of aromatic rings and high molecular weight of PAHs result in low water solubility and high *K<sub>oc</sub>* (Table 5-1) for these compounds. The high *K<sub>oc</sub>* values and elevated levels of organic carbon at the Site (9.4 percent), and thus high *K<sub>d</sub>* values, indicate a strong tendency for these compounds to partition to the organic matter in soil, resulting in their removal from the dissolved phase.

Based on the calculation of Site-specific retardation factors as presented in Table 5-2, the rate of migration of benzo(a)pyrene in groundwater is expected to be over five orders of magnitude (244,800 times) slower than the advective groundwater is estimated to flow. As a lighter PAH with a lower *K<sub>oc</sub>* value, dissolved-phase naphthalene in groundwater will move over two orders of magnitude (287 times) slower than groundwater at the Site. In consideration of the effects of retardation of dissolved-phase PAHs, travel times for these constituents would be reduced severely. For example, using the linear flow velocity in the shallow unconfined groundwater (0.55 foot per day, assuming homogeneous conditions), and accounting for retardation, dissolved-phase naphthalene in groundwater near the MW-103 cluster would be expected to take approximately 857 years to travel 600 feet to the southeast, a rate of 0.7 feet per year, before discharging along the northern shoreline at the former Lever Brothers property to the Hudson River. Benzo(a)pyrene would take significantly longer. Because of naphthalene's mobility relative to benzo(a)pyrene and other PAHs observed at the Site, and because it is the most widely distributed PAH in groundwater, this section looks at naphthalene as a conservative indicator of PAH migration in groundwater.

Primary lines of evidence indicate that naphthalene at the Site is not currently migrating. Specifically, groundwater data from each of the four RI groundwater sampling events were plotted and contoured to illustrate the change in the lateral distribution of naphthalene concentrations across this 1-year time frame. These plumes are compared side-by-side in Figure 5-6, and illustrate that naphthalene is stable and has not migrated farther than approximately 100 feet hydraulically downgradient of the mapped lateral extent of NAPL (Figure 4-4). This lateral distance is in general agreement with what would be anticipated on the basis of the above calculated retardation/transport factors. However, it should be noted that the calculated rate for naphthalene migration in groundwater takes into account neither preferential transport associated with small-scale zones of increased hydraulic conductivity nor the presence of confounding downgradient sources at the former Lever Brothers property, both of which may have contributed to a greater observed plume length than the retardation might predict. In addition, graphs of naphthalene concentrations with time

measured in samples collected from select wells along and within the plume are included herein as Appendix O. Historical groundwater data from as early as 1998 and data collected as part of the RI are included when available and show that, across this 9-year timeframe, concentrations of naphthalene in groundwater are stable or are decreasing.

There are, however, areas at the Site where secondary sources of NAPL are contributing to dissolved naphthalene and other PAHs near the Hudson River. Adjacent to the wooden bulkhead at the Quanta property (NZ-2) and to the north near monitoring well MW-C (NZ-5) where NAPL is present, concentrations of dissolved-phase naphthalene range from 27 to 36,000 µg/L. Given the understanding of advective groundwater flow and that elsewhere at the Site naphthalene has migrated in groundwater as far as 175 feet from sources of NAPL, dissolved-phase naphthalene, and to a lesser extent other less mobile PAHs, can be assumed to be migrating in groundwater from OU1 toward the Hudson River.

However, as the concentrations of PAHs move from OU1 and upward through the sediments in OU2, they will be subject to additional absorption and degradation processes and will be at lower concentrations than those measured in the monitoring wells adjacent to the Hudson River. If discharged to the surface water they would be subject to volatilization and photolysis which will result in a further reduction of concentrations. The half-life of naphthalene in river water is estimated to be approximately 3 hours (TOXNET, 2007). Quantification of PAH concentrations in the shallow pore water downgradient of OU1 in the Hudson River is proposed as part of the SRI.

### **Non-PAH SVOCs**

Other non-PAH SVOCs have higher solubilities and lower *K<sub>oc</sub>* values that may result in increased mobility in groundwater compared to PAHs. SVOCs such as phenols and nitrobenzene exceeded the applicable groundwater screening criteria in fewer RI groundwater samples than PAHs. These constituents are found primarily in the central portions of the Site and do not extend beyond the footprint of the naphthalene plume. The reduced plume size is likely a result of their reduced presence in secondary sources of NAPL relative to PAHs and indicates that these SVOCs do not appear to be migrating in groundwater from secondary source areas (i.e. NAPL zones).

Despite the limited extent of non-PAH SVOCs in groundwater relative to NAPL zones within the interior of the Site (NZ-1 and NZ-3) these compounds are present above screening criteria in groundwater adjacent to the wooden bulkhead (NZ-2). Because they are present in groundwater samples collected from wells adjacent to OU2, these SVOCs, like naphthalene, can be assumed to migrate in groundwater towards the Hudson River. Similar to naphthalene, non-PAH SVOCs will be subject to additional attenuation as they move through the sediments of OU2. The half-life of phenols and nitrobenzene in river water are estimated to range between 1 and 3 days (TOXNET, 2007). Unlike naphthalene, non-PAH SVOCs do not extend north of the wooden bulkhead to monitoring well MW-C (NZ-5). Quantification of non-PAH SVOC concentrations in the shallow pore water downgradient of OU1 in the Hudson River is proposed as part of the SRI.

### **5.5.2 Volatile Organic Compounds**

With lower molecular weight and higher solubility in water, VOCs will have the tendency to be more mobile than SVOCs in groundwater. The most frequently-detected VOCs

detected at the Site include BTEX compounds. The presence of benzene is discussed in detail to illustrate the fate and transport of aromatic VOCs in groundwater at the Site because its properties are similar to other aromatic VOCs and because benzene was identified over the largest area and is the most mobile of these compounds identified in groundwater at the Site. In addition to the BTEX compounds, chlorinated solvents also have been detected above the applicable screening criteria in groundwater at the Site, primarily in the deep sand unit. Chlorinated solvents in groundwater are believed to be the result of an offsite source and are migrating beneath the Site within the deep sand unit. The fate and transport of chlorinated solvents detected at the Site are included in the discussion.

### Aromatic VOCs

Benzene has a moderate tendency to adsorb to organic matter. As described in Section 5.1.1, the Koc value for benzene is almost 20 times less than that of naphthalene and, thus, the Site-specific-Kd value for benzene is an order of magnitude lower (2.4 mL/g) than that of naphthalene. Therefore, the retardation factor for benzene (Table 5-2) results in a transport rate in groundwater approximately 15 times slower than the average linear velocity of groundwater at the Site.

Benzene would be expected to travel faster than most other Site-related compounds in groundwater due to its relatively higher solubility and lower Koc. Based on the calculated retardation factor of 15, benzene could be expected to travel the 600-foot distance from the MW-103 cluster (NZ-3) to the Hudson River near the former Lever Brothers property in approximately 45 years. The earliest NAPL present in the subsurface containing benzene was present in this area at or before this time (1962), which suggests that without other attenuation mechanisms, such as biodegradation, a significant mass of benzene would be present today adjacent to Hudson River downgradient of the Quanta property. However, this is not the case. Benzene in groundwater samples collected from the MW-109A and MW-109 wells that are hydraulically downgradient and adjacent to Hudson River have consistent concentrations below method detection limits (nondetect), and 5 µg/L, respectively. This is strong evidence that degradation mechanisms are at play and are attenuating aromatic VOCs in groundwater related to the Site.

The attenuation of benzene in groundwater is also evidenced in the stability of concentrations and plume geometry over time. This stability is illustrated in graphs of benzene concentrations over time in samples collected from select wells along and within the plume (Appendix O). Historical groundwater data from as early as 1998 and the data collected as part of the RI are included when available and show that across this 9-year time frame, concentrations of benzene in groundwater are either stable or decreasing. In addition, groundwater data from each of the four RI groundwater sampling events were plotted and contoured to illustrate the change in the lateral distribution of benzene concentrations across this 1-year time frame. These plumes are compared side-by-side in Figure 5-7. The plumes exhibit nearly identical concentrations, and have similar aerial dimensions, as well as similar overall geometries over the period of record. These consistent relationships with time are primary lines of evidence that the extent of aromatic VOCs in groundwater is stable.

Similarly to naphthalene, benzene is present in groundwater samples collected from wells adjacent to OU2 (NZ-2 and NZ-5). Due to its presence here it can be assumed that benzene,

like naphthalene migrates further from these locations in groundwater towards the Hudson River. As this occurs it will be subject to additional attenuation as groundwater moves through the sediments of OU2. With a half life of approximately 1 hour, benzene will volatilize rapidly if discharging to the river (TOXNET, 2007). Quantification of aromatic VOC concentrations (including benzene) in the shallow pore water downgradient of OU1 in the Hudson River is proposed as part of the SRI.

### **Chlorinated VOCs**

The highest concentrations of chlorinated solvents in the unconfined shallow groundwater unit were detected in groundwater outside the footprint of historical Site operations at monitoring wells MW-B (former Celotex property) as well as MW-29, MW-106A, and MW-122A (former Lever Brothers property). Chlorinated VOCs detected in shallow groundwater at the Site above screening criteria do not form contiguous plumes and appear to represent low-level concentrations localized to individual well locations where they have been detected. Concentrations of TCE and PCE within the deep sand unit are up to 3 orders of magnitude greater than those observed in shallow groundwater and are greatest in the most upgradient sampling location (460 µg/L at monitoring well MW-101DS).

The transport of TCE and PCE and their degradation products from Site-related sources to the deep sand unit are not occurring, as demonstrated by the following facts.

- Consistent upward groundwater flow gradients from the deep sand unit to the shallow unconfined unit demonstrate that the silty clay is a hydraulic barrier and that groundwater and the dissolved-phase constituents in groundwater are not able to be transported to the deep sand unit.
- Vertical groundwater concentration gradients (i.e., significantly higher concentrations in the deeper sand unit) indicate that the source of these chlorinated VOCs comes from source areas hydraulically connected to the deep sand unit;
- Horizontal groundwater concentration gradients (i.e., higher concentrations in upgradient portions of the Site [Block 93 North]) suggest that the source is present upgradient of the Site.

Concentrations of TCE and PCE in groundwater detected in the deep sand hydrostratigraphic unit are being attenuated through reductive dechlorination. This is evidenced in the decreasing concentrations of PCE and TCE in the downgradient direction, as well as the presence of the less-chlorinated daughter products (cis-1,2-DCE and vinyl chloride). Low levels of TCE have migrated from offsite sources in the deep sand as far MW-116DS, adjacent to the wooden bulkhead. Groundwater in this area is anticipated to travel farther eastward in groundwater where it will eventually discharge to the Hudson River. With a half-lives ranging between 1 and 3.5 hours chlorinated VOCs are expected to volatilize rapidly upon discharging to the river water (TOXNET, 2007). Quantification of TCE concentrations in the shallow pore water downgradient of OU1 in the Hudson River is proposed as part of the SRI.

### **5.5.3 Metals**

To determine the fate and transport of inorganic constituents present at the Site, detailed evaluations of geochemical conditions and inorganic contaminant sources and distribution

are based on the fundamental principles that govern their state and ultimately their behavior in groundwater.

As stated previously, redox conditions at the site are controlled by the sources of organics, including native peat as well as coal tar. Because of increases in microbial activity as a result of the presence of dissolved organic contaminants, the distribution of lower Eh (less than 0 mV) values is similar to that of the dissolved-phase contaminant plume associated with the coal tar (Figures 5-1 and 5-2). The combination of Eh and pH conditions will dictate the reductive dissolution of redox-sensitive metals (e.g., iron) that may serve as key adsorption sites for other constituents (e.g., arsenic). In addition, the reduced conditions resulting from the presence of dissolved-phase coal-tar impacts can affect the affinity of key metals to adsorb by reducing their ionic strength, thus promoting greater mobility in groundwater.

The following sections focus on presenting information about the observed Eh and pH conditions in groundwater at the Site and their effect on mineral precipitation and dissolution, and adsorption relative to key metals (arsenic, iron, and lead) associated with both the former acid plant as well as the ubiquitous fill material.

### Geochemical Zones

Geochemical zones were mapped to obtain a greater understanding of variable geochemical conditions across the Site, including adjacent properties, and to understand their influence on constituent fate and mobility. In shallow groundwater, five distinct geochemical zones were mapped based on measurements of pH, Eh, and dissolved oxygen, as well as arsenic and iron concentrations. The extent of each zone is illustrated in Figure 5-8. In Zone 1A the geochemical signature of the groundwater is influenced by historical operations related to the former sulfuric acid plant. In Zones 1B, 2, and 3, geochemical signatures reflecting elevated levels of organics in the presence of secondary sources of heterogeneous fill that contains varying levels of metals. In general, conditions at Zones 4 and 5 are more representative of regional background, with some fill and lesser amounts of organics than other zones. The criteria for describing and categorizing the varying redox environments used to map and describe the geochemical facies are presented in Figure 5-9. The collection of additional major ion chemistry data from existing and newly installed wells has been proposed as part of the SRI. These additional data will be used to refine future geochemical mapping of the Site.

**Zones 1A and 1B: Acidic pH, Elevated Iron and Arsenic Concentrations.** Zone 1A coincides with shallow groundwater arsenic plumes in the MW-N-1/MW-A and MW-113 monitoring well clusters area. Zone 1B centers around the series of MW-107 monitoring wells. The geochemistry of Zones 1A and 1B exhibit a distinct signature with acidic pH, transitional to suboxic Eh, hypoxic (dissolved oxygen between 1 and 2 mg/L) to anoxic (dissolved oxygen less than 1.0 mg/L) conditions, elevated arsenic (greater than 1,000 µg/L), and elevated iron (greater than 100 mg/L). Zones 1A and 1B exhibit the most distinctive geochemical signature at OU1. In the MW-N-1 area, Zone 1A is associated with pyritic waste in the vadose zone. Reduced groundwater conditions in this area result from the consumption of DO by the oxidation of pyrite that creates acidic conditions (leaching of acid wastes). DO is also consumed by the oxidation of organic matter. In Zone 1A, mineralogical evaluations of the reddish-purple soils indicate ongoing oxidation of unburned or partially burned pyrite that is the likely cause of these acidic groundwater conditions (Section 5.4.5). In Zone 1B,

organic matter and historical “caustic”<sup>20</sup> tanks (Figure 1-3) immediately adjacent to these wells are the likely causes of this geochemical signature. Pyritic waste material has not been observed near the MW-107 series monitoring wells.

**Zone 2: Mildly Acidic pH, Elevated Iron, and Arsenic Concentrations.** Zone 2 indicates elevated arsenic concentrations centering on the MW-111 monitoring well cluster. Geochemically, this zone exhibits a slightly acidic pH between 6.0 and 7.0, transitional Eh, anoxic dissolved oxygen concentrations, elevated arsenic concentration (greater than 10,000 µg/L), and elevated iron concentration (greater than 100 mg/L). Unlike Zone 1A, Zone 2 does not appear to exhibit a distinct pyrite oxidation signature. Although arsenic and iron concentrations are highly elevated, pH is in the neutral range. Physically, Zone 2 is not visually associated with pyritic waste in the vadose zone. Arsenic appears to emanate from mixed fill containing slag, cinders, and other debris where the reduced Eh of groundwater has caused the dissolution of important arsenic adsorption sites, resulting in its release to groundwater in this zone. Unlike in Zone 1, Eh is constrained by anoxic dissolved oxygen concentrations.

**Zone 3: Elevated Organics, Arsenic, and Iron.** Zone 3 spans the area of OU1 between monitoring wells MW-102 and MW-112 east of River Road, then southeast to MW-120 and MW-117 at the Hudson River. Although the zone was mapped for other chemical constituents, groundwater from monitoring wells in Zone 3 contain TOC concentrations greater than 1 mg/L, which is the result of the presence of organic contaminants associated with NAPL and soil. Stoichiometrically, to exert any noticeable influence on groundwater chemistry, organic concentrations in groundwater typically need to exceed 1 mg/L.

Groundwater in Zone 3 exhibited slightly acidic to neutral pH. Dissolved oxygen values are anoxic and reduced Eh values fell in the sulfate (meta) stable range. Arsenic concentrations ranged as high as 28,800 µg/L but decreased from the source at the former acid plant. Dissolved iron was observed at concentrations up to 77 mg/L, where data were available.

The pH and Eh of Zone 3 play a significant role in the mobility iron and arsenic in proximity to secondary sources of these metals within and hydraulically upgradient and adjacent to Zone 3. Zone 3 redox conditions are a direct result of the presence of NAPL and soil impacts.

**Zone 4: Slightly Acidic to Alkaline pH, Transitional to Suboxic Eh, in Coastal Area.** Zone 4 lies in two segments adjacent to the Hudson River. Zone 4 is bisected by Zone 3 where the organic plume contains total organics greater than 1 mg/L and contacts the Hudson River. Zone 4 extends on average 140 feet west of the river, where it grades into Zone 5. Zone 4 and Zone 5 present the least distinctive geochemical signatures at OU1. Any boundary between the two zones appears gradational and could change according to the analytical variability of single sampling events.

Zone 4 is characterized by slightly acidic to slightly alkaline pH, transitional to suboxic Eh, hypoxic to oxic dissolved oxygen, low arsenic concentrations where detectable (less than 100 µg/L), and predominantly low iron concentrations (less than 2 mg/L). In the northern

---

<sup>20</sup> The term “caustic” at this time likely referred to corrosive substances, whether acidic or basic.

portion of Zone 4 at the former Celotex property, pH values are alkaline, and dissolved oxygen concentrations are relatively oxic (MW-J).

With a more neutral pH than Zones 1A and 1B and a greater redox potential than Zones 2 and 3, Zone 4 most likely acts as a natural mechanism to significantly reduce arsenic from the dissolved mobile phase.

**Zone 5: Slightly Acidic pH, Sulfate Reducing to Suboxic Eh—Site Background.** Zone 5 is the largest geochemical zone, and it appears to represent Site background conditions. These geochemical conditions consisted of slightly acidic pH; wide variability in Eh, indicating primarily suboxic to transitional redox conditions; variable dissolved oxygen concentrations; low arsenic concentrations (less than 10 µg/L); and varying iron concentrations. Eh, dissolved oxygen, and iron values appeared to vary according to the amount of cover over specific areas and hydraulic connection to oxygenated recharge. Zones 4 and 5 appeared gradational, but the geochemical signature of Zone 5 is distinct from Zones 1 through 3.

As in Zone 4, the more neutral pH and greater redox potential in Zone 5 appears to act as a natural media to significantly reduce arsenic from the dissolved mobile phase.

## Arsenic

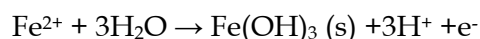
There are multiple lines of evidence suggesting that dissolved arsenic is being removed from solution in close proximity to any secondary arsenic-containing source material through the processes of precipitation and adsorption.

**Key Attenuation Processes.** Based on the groundwater geochemistry data for the Site it appears that the formation of iron oxyhydroxide adsorption sites and the ionic strength of arsenic are the most important factors for arsenic attenuation and mobility in groundwater at the Site. Both these factors are controlled by pH and redox conditions and will change dramatically between varying Geochemical Zones. The geochemical principles controlling these processes as well as the Site data and modeling that supports that they are playing a key role at the Site are discussed briefly in the following paragraphs. The effects of these mechanisms on the transport of arsenic in groundwater at the Site are presented in context of each discrete area of elevated arsenic concentrations in the following sections.

The relationship between redox, pH, and the valence state of arsenic is conceptually illustrated in the arsenic speciation diagram that plots redox potential as Eh and is included as Figure 5-10. To evaluate the state of arsenic in Site groundwater, the median Site-specific values for Eh and the pH for each well across all RI groundwater sampling events have been plotted in context of the arsenic-speciation diagram in Figure 5-10. These data show that in groundwater at the Site, arsenic predominantly exists as  $\text{H}_3\text{AsO}_3^0$  (the neutral form of arsenite) or as  $\text{H}_2\text{AsO}_4^-$  (the least negatively charged form of arsenate). In a number of samples, these species are likely in equilibrium with one another.

The negatively charged arsenate species has a greater affinity for adsorption to sites than that of the typically neutral arsenite. Under oxidizing conditions arsenate will be more prevalent whereas under reducing conditions arsenite will be more abundant (Deutsch, 1997). These data suggest variability in the adsorption strength of arsenic between the different geochemical zones.

The ability of arsenic to be adsorbed is also a function of the stability and valence state of other metals, particularly iron, that will control the formation and abundance of minerals that serve as important adsorption sites for arsenic. In fact, the most common cause of widespread arsenic contamination in the United States is believed to be a result of arsenic desorption caused by the reductive dissolution of iron oxyhydroxides (Welch et al., 2000). The formation of these important adsorption sites is also controlled by pH-redox conditions. Under more oxidizing conditions, ferrous iron present in most groundwater systems will be oxidized to the ferric iron ( $\text{Fe}^{3+}$ ) redox state, which then generally precipitates as iron oxyhydroxides. Under more reducing acidic conditions, ferric iron will be reduced to ferrous iron ( $\text{Fe}^{2+}$ ) causing the dissolution of iron oxyhydroxides and, thus, releasing adsorbed arsenic, as well as other metals and metalloids, back into solution. This process is expressed in the half-cell reaction shown below:



The relationship between redox and pH and the valence state of iron is illustrated in the iron system diagram, which plots redox potential as Eh versus pH. To illustrate the effects of iron on the presence of arsenic in the groundwater at the Site, the median measured Eh and pH for Site groundwater samples have been plotted in context of the iron system for the different ranges of arsenic concentrations and are shown in Figures 5-11a through 5-11d. As illustrated in Figure 5-11a and 5-11b, the majority of elevated arsenic concentrations in groundwater (plotted as red triangles and purple diamonds) are present at locations where the Eh-pH relationship indicates that iron oxyhydroxides are not stable, thus reducing the available adsorption sites for arsenic.

The inverse relationship of iron oxyhydroxide formation and arsenic concentrations in groundwater at the Site is strong and indicates that this is the most important mechanism controlling the transport of arsenic in groundwater from the various sources.

Arsenic can also be removed from groundwater through its incorporation into various minerals as they precipitate under certain geochemical conditions (absorption). Under oxidizing conditions arsenic can precipitate as the mineral scorodite ( $\text{FeAsO}_4 \cdot 2\text{H}_2\text{O}$ ). However, this mineral is relatively soluble and thus is not anticipated to contribute significantly to the removal of arsenic from Site groundwater (Deutsch, 1997). Under very reducing conditions and in the presence of extremely high concentrations of sulfide, dissolved arsenic-sulfide species can be significant. Reducing, acidic conditions favor precipitation of orpiment ( $\text{As}_2\text{S}_3$ ), realgar ( $\text{AsS}$ ) or other sulfide minerals containing coprecipitated arsenic which will result in a reduction of arsenic in groundwater (Smedley and Kinniburgh, 2002). The precipitation of these minerals is not anticipated to be occurring appreciably at the Site as groundwater is not reducing enough to favor these reactions.

As part of the SRI, installation of additional monitoring wells and the collection of major ion chemistry data have been proposed. Obtaining these additional data will enable further understanding of the Site-specific Eh-pH relationships to iron, sulfate, and bicarbonate concentrations and will document the types of location- and site-specific attenuation mechanisms within and across the varying geochemical zones, as well as adsorption capacity and the minerals that are involved. If appropriate, this comprehensive data set will be used to develop a geochemical model using MINTEQA2 (EPA, 1992c) or similar software.



**Arsenic Mobility in Site Groundwater.** The following four distinct areas of elevated arsenic concentrations (greater than 1,000 µg/L) have been observed in groundwater at the Site: (1) Block 93 North near the MW-111 series monitoring wells, (2) area near the former acid plant in the northwest portion of the Quanta property and the southwest portion of the Celotex property, (3) the northern portion of the former Lever Brothers property near the MW-107 series wells, and (4) the central portion of the former Lever Brothers property near the former P/A area. In each one of these areas, arsenic concentrations in groundwater are a function of the source of arsenic and groundwater geochemistry near localized sources. Sources of arsenic include pockets of slag and cinders related to fill material and pyritic material from the former acid plant, as is the case in the northwest portion of the Quanta property and the southern portion of the Celotex property.

To illustrate the physical separation between each of these high-arsenic areas in groundwater, arsenic concentrations were contoured on transects parallel to the various directions of groundwater flow at the Site that intersect one or more of the areas with high-arsenic concentrations in groundwater. For this exercise, cross-section A-A' as referenced in Section 3 was used, and three new cross-sections (E-E', F-F', and G-G') were created to represent the varying directions of groundwater flow at the Site and that intersected one or more of the high-arsenic concentration areas. These arsenic plume cross-sections are provided in Figures 5-12 and 5-13. The separation of the various areas with high arsenic concentration in groundwater is illustrated in these plume cross-sections where decreasing concentrations are observed between each area of elevated arsenic impacts in groundwater discussed above.

Although significant reductions in arsenic concentrations are evident between areas of elevated arsenic concentrations (Figures 5-12 and 5-13), negative control points (indicating the complete absence of arsenic in groundwater) between these suspected source areas are not always present in the data set from the current groundwater-monitoring network. Although the current data set provides strong evidence for arsenic attenuation between the zones of elevated arsenic concentrations in groundwater, the level of effectiveness of the attenuation mechanisms and their capacity for removing arsenic so that advective transport of this constituent may become exhausted remains uncertain. These uncertainties will be addressed as part of the SRI, which will involve the collection of additional groundwater data along key transects and downgradient of elevated arsenic concentrations in groundwater where attenuation is believed to be occurring. In addition, collocated soil samples will be analyzed using a sequential extraction procedure for arsenic in accordance with EPA (2007d) guidance. These soil samples will provide quantitative evidence of whether arsenic is being attenuated and of both the effectiveness and capacity of future attenuation mechanisms in these key transition zones.

The trend of arsenic concentrations over time at monitoring wells within and along the leading edge of the groundwater impacts associated with each of these areas with high arsenic concentrations indicate that attenuation through precipitation and adsorption (as described above) is sufficient to stabilize and prevent further migration of arsenic. Graphs of arsenic concentrations versus time in shallow groundwater measured in samples collected from select wells along and within areas with high arsenic concentrations are included herein as Appendix O. Historical groundwater data from as early as 1998 collected by other consultants as well as the data collected as part of the RI are included when available and in

general show that across this 9-year time-frame concentrations of arsenic in groundwater are stable. The one exception appears to be monitoring well MW-C, where increases in concentrations of arsenic in the groundwater at the Celotex property between 2003 and 2006 could be a result of disturbances associated with the redevelopment of that property that was ongoing during the time period. Another factor that would likely impact groundwater conditions is the placement across this area of an impermeable pavement structure, which prevents localized influx and recharge of oxygen-rich atmospheric air and rain water, thus resulting in more-reduced groundwater conditions, which may be promoting further dissolution of arsenic in the vicinity of MW-C.

To further illustrate the stability of the arsenic plumes, groundwater data from each of the four RI groundwater sampling events were plotted and contoured to illustrate the change in the geometry of the arsenic plumes across this 1-year time frame. Arsenic plumes are compared side-by-side in Figure 5-14 and again illustrate that arsenic in groundwater is stable, and the plume does not appear to be expanding. Because of the limited availability of arsenic data for some of the wells shown and used in contouring in Figure 5-14, groundwater data from the most recent sampling event were used to develop the contours for each map. Collection of additional arsenic data across key wells, defining the extent of arsenic impacts, will take place two additional times throughout the span of a year as part of the SRI. These data will be used to develop contour maps for arsenic that will be compared to historical data in order to continue evaluating the stability of the arsenic plume over time.

The attenuation of arsenic in groundwater moving from each of these distinct areas with high concentrations and, in turn, the geometry of the plumes is controlled by geochemical transitions associated with the movement of groundwater from these areas to Geochemical Zones 4 and 5. As detailed above these less acidic and less reducing zones promote the precipitation of iron oxyhydroxides and the adsorption of arsenic. The distance that arsenic may be able to travel is a function of where these changes in geochemistry occur relative to the source, the types of geochemical changes, and the intensity of the source. As a result, the geometry of each plume will not be the same for each area with elevated arsenic levels. The sources, geochemical conditions, and attenuation processes are discussed in detail for each of the areas with high concentrations of arsenic in groundwater. These discussions are based on the available data collected to date. Additional data collected as part of the SRI will be used to address uncertainties regarding these interpretations of the available data and to refine the conceptual model of arsenic transport along key groundwater flow transects across the Site.

***Former Acid Plant Area (Zone 1A).*** The highest concentrations of arsenic in groundwater are found near the former acid plant. Groundwater in this area is slightly oxidizing and acidic (pH values ranging from 4.1 to 6.6). Groundwater in the former acid plant area exhibits a typical pyrite oxidation profile with low pH, oxidizing Eh, and elevated concentrations of iron and arsenic. As a result of the redox and pH, iron oxyhydroxides are not able to precipitate; thus, arsenic remains in solution near the former acid plant source material. Immediately adjacent to and hydraulically downgradient of the area where the acid plant source material has been documented to exist (Section 4), the effects of increases in pH coinciding with the reduction of arsenic concentrations can be seen. Groundwater in the southern portion of the acid plant impacts (northwest portion of the Quanta property) flows to the south and passes into Geochemical Zone 3, where the presence of NAPL and soil

contamination have resulted in elevated concentrations of total organics (greater than 1 mg/L) present in groundwater. The pH of the shallow groundwater in this direction increases to a pH 6.2 at MW-112A and MW-112B. As a result, iron oxyhydroxides are able to precipitate even under mildly reducing conditions, arsenic is adsorbed to the iron minerals, and arsenic concentrations are reduced by two orders of magnitude at a distance of less than 50 feet from the documented pyritic source material (Figure 5-12).

Although arsenic is strongly attenuated to the south of the source zone at MW-112A and MW-112B, concentrations at these wells remain around 965 and 21,800 µg/L, respectively. This is likely a function of the amount of arsenic in the system that is just downgradient of the pyritic source material, which could be exceeding the capacity of adsorption sites. In addition, the reducing conditions within Zone 3 cause the reduction of arsenic to arsenite, and adsorption of this less strongly held species allows arsenic to remain in solution. Farther in this hydraulically downgradient direction, arsenic is almost completely attenuated as groundwater transitions to a more oxidizing environment, and concentrations at MW-114A and MW-114B have been measured at 7.2 and 3,810 µg/L, respectively.

In groundwater to the east of the pyritic source material and in the direction of the Hudson River, arsenic attenuates much more quickly in the Geochemical Zone 5 environment. With significantly more oxidizing conditions than Zone 3 and a near neutral pH, arsenic becomes dominated by the more readily adsorbed arsenate species and is attenuated dramatically as iron oxyhydroxides precipitate forming adsorption sites. As groundwater here moves into Zone 5, the concentrations of arsenic are reduced dramatically as evidenced at MW-20 where arsenic is reduced to 102 µg/L.

Still farther to the east along the Hudson River, arsenic concentrations increase again at MW-O and MW-C as groundwater becomes less oxidizing due to the increased presence of organics associated with NAPL Zone 5. As a result arsenic associated with fill material has been reduced and released to groundwater just upgradient of the Hudson River where coal tar is present.

Still closer to the Hudson River, the groundwater transitions to Geochemical Zone 4. Here, and in portions of Zone 3 to the south of the wooden bulkhead, pH increases slightly and is generally neutral. Dissolved oxygen concentrations also increase and groundwater becomes relatively oxic, which likely is due to the tidal fluctuations along with mixing and oxygenation of surface water with groundwater adjacent to the Hudson River. As a result, iron has precipitated as iron oxyhydroxides, and both iron and arsenic concentrations in groundwater significantly decrease. Arsenic concentrations here are generally below detection limits. The one exception to this is MW-C, where arsenic concentrations remain at 987 µg/L within 100 feet of the Hudson River.

The decreased concentrations of arsenic and iron measured in groundwater immediately adjacent to the river demonstrate that the oxygenation of groundwater in the mixing zones creates an oxidizing environment that serves as a barrier for arsenic transport to the Hudson River through the promotion of iron oxyhydroxide adsorption sites for arsenic. Similarly, any arsenic that is not scavenged from groundwater prior to moving from OU1 (as is potentially the case for groundwater near MW-C) will be attenuated and adsorbed to sediments as groundwater moves into the typically more reducing sediment environments where conditions may favor the precipitation of arsenic as sulfide minerals (Smedley and

Kinniburgh, 2002). Arsenic results for sediment samples collected at OU2 and presented in the OU2 PSCR confirm that groundwater discharge from OU1 has not appreciably affected arsenic concentrations in surface sediments. Concentrations of arsenic in the OU2 river sediment were not significantly higher than upstream or downstream sample groups (CH2M HILL, 2007j). As part of the SRI, an additional monitoring well will be installed and sampled for arsenic between MW-C and the shoreline, and pore water samples will be collected within OU2 to determine if arsenic from this area is being attenuated before discharge from groundwater to the surface water at OU2.

Groundwater samples collected between 2003 and 2005 by TRC Raviv (Raviv, 2005) within and downgradient to the east of the former acid plant area (monitoring wells MW-A-1, MW-A-2, MW-N-1, MW-N-2, MW-B, and MW-O) are consistent with concentrations detected in samples collected during the RI (see Appendix O). Regardless of the sources that are contributing to concentrations of dissolved-phase arsenic in this area, the consistency of these concentrations across time demonstrates that the distribution of arsenic in groundwater in this area is stable.

***Monitoring Well MW-107 Area (Zone 1B).*** Significant increases in arsenic concentrations are observed in the shallow groundwater as the geochemistry transitions from Zone 5 (background) downgradient of MW-114A and MW-114B to the south to Zone 1B near MW-107. Groundwater concentrations of arsenic increase by four orders of magnitude as the pH becomes acidic and iron oxyhydroxides dissolve increasing iron concentrations in water and the release of arsenic associated with the slag-rich fills (shown in Figure 5-13). Zone 1B is limited in extent; however, within 130 feet, arsenic released from sources in this area is attenuated downgradient in the direction of MW-115A and MW-115B as the pH increases, and concentrations within the shallow and intermediate zones decline to 74.1 µg/L and nondetect, respectively. However, data collected by GZA indicates the presence of arsenic in a groundwater sample collected from well MW-51A at a concentration of 269 µg/L. Sampling of newly installed monitoring wells and existing monitoring well(s) installed by GZA (including MW-51A) will be conducted downgradient of MW-107 in the direction of the Hudson River to document that attenuation of arsenic related to MW-107 occurs before reaching the Hudson River. It should be noted that additional sources of arsenic in groundwater related to the former Lever Brothers property are affecting groundwater immediately south of this area (e.g., MW-32 and MW-33), and arsenic contour mapping of these data, provided in GZA (2007b), shows that these impacts may be reaching the Hudson River.

***MW-111 Series (Zone 2).*** In the area of the MW-111 well series, concentrations of arsenic are at the high end of the range of concentrations that were detected within the fill during the RI (988 mg/kg at SB-28). Elevated concentrations in groundwater are observed in the slightly oxidized (Eh between 0 and 100 mV) and slightly acidic groundwater. As shown in the equilibrium-phase diagram for iron, under this mix of Eh and pH conditions, iron will have the tendency to dissolve, and arsenic may be present as reduced arsenite species. Approximately 140 feet to the east, arsenic analytical results from a groundwater grab sample at TWP-SB-32 were an order of magnitude lower than the groundwater sample(s) collected at monitoring well MW-111. Despite this lower concentration gradient between the MW-111 series wells and the pyritic source material hydraulically upgradient to the east, a

definitive control point indicating that these two areas are distinct has not yet been established. This work has been proposed as part of the SRI.

Approximately 220 feet to the southeast, at monitoring well MW-101A, arsenic concentrations are three orders of magnitude lower. Farther from the source area and from the area where neutral pH conditions exist and iron oxyhydroxides precipitate, arsenic becomes more strongly sorbed as the negatively charged arsenate species.

The extent of the arsenic-impacted fill and elevated concentrations of arsenic in groundwater to the west of the MW-111 monitoring well series have not yet been fully delineated. Additional work will be performed as part of the SRI to complete this delineation and document whether arsenic observed at the MW-111 well series is a result of advective transport from the pyritic material to the east or whether it is a result of the dissolution of arsenic from localized fill deposits. Whether the impacts at the MW-111 series wells indicate a localized source of arsenic is present or not, existing data demonstrate that arsenic in this area does not appear to migrate toward eastward in the direction of the Hudson River. In other words, arsenic in this area is attenuated well before groundwater discharges to the Hudson River.

*Former Lever Brothers P/A Area (Zone 3).* Farther south of the MW-107 well series, groundwater becomes moderately reduced again (Zone 3) because of sources of organic constituents related to operations at the former Lever Brothers property. These organic constituents include elevated concentrations of PAHs and benzene in monitoring wells MW-4, MW-32, and MW-36. Groundwater in this area is neutral to slightly acidic. As Eh values approach and decrease below about -100 mV in this area (Figure 5-1), arsenic related to the fill is reduced to arsenite and iron oxyhydroxides dissolve, resulting in a release of arsenic from the fill. The separation of these arsenic impacts in groundwater from those farther to the north at the MW-107 well cluster, as illustrated in Figure 5-13 (cross-section F-F') and Figure 5-14 (plan view of arsenic plumes over time), further suggests that the sources of these two areas of arsenic concentrations in groundwater are separate.

## Lead

Lead, like arsenic, is neither a constituent of Site-related NAPL nor a byproduct of the coal-tar or oil-recycling operations associated with the Site. The primary source of lead is the storage and combustion of pyritic ore. An additional source of lead in soil and groundwater is the ubiquitous presence of heterogeneous slag-rich fill present at the Site and across all the properties throughout this area.

Unlike arsenic and iron, lead itself is not sensitive to changes in redox conditions. However, similarly to arsenic, lead concentrations in groundwater are attenuated through its adsorption to naturally occurring organics and iron oxyhydroxides, the latter being sensitive to changes in redox conditions. As a stable metal cation, lead will become increasingly adsorbed with increases in pH. Lead also can precipitate as relatively insoluble minerals in the presence of phosphate and carbonate, which will limit its mobility in groundwater. In general, lead is strongly adsorbed under a wide range of pH and Eh conditions and would not be transported readily in groundwater.

The distribution of lead in groundwater is distinctly different than that of arsenic and iron and is focused almost exclusively in the area of the former acid plant because of differences

in the nature, extent, and intensity of the pyritic sources versus that of the regional fill material. Elevated levels of lead in soil are present throughout the former Celotex property with concentrations as high as 38,800 mg/kg within the pyritic material but are not as abundant elsewhere (Figures 4-21 and 4-22). Although lead is present in the fill material, the lead associated with pyritic material at the former acid plant may pose a greater threat to groundwater due to its higher concentrations and to the generation of acidic groundwater conditions during the pyrite oxidation process, which will dissolve lead minerals in groundwater. This release of lead to groundwater is evidenced in the SPLP results from analysis of the samples of reddish-purple soils containing pyrite from October 2006 and June 2007. Results of the analyses show that significantly higher concentrations of lead leach from the reddish-purple soil (as high as 11,500 µg/L) compared to leaching from samples of the slag-rich fills (only as high as 7 µg/L).

Lead concentrations in groundwater were highest in samples collected from monitoring well MW-A-2 (ranging from 536 to 4,100 µg/L). The presence of these concentrations in groundwater is due to the intensity of lead concentrations associated with the pyritic source, which in groundwater proximal to this source will overwhelm the adsorption sites available to lead. Due to the relative immobility of lead, elevated concentrations of lead do not persist in groundwater downgradient to the south or east of this source because lead is quickly precipitated or adsorbed to organics or hydroxide minerals.

Concentrations of lead decline dramatically to the south at monitoring well MW-112A (50.2 µg/L), immediately adjacent to the reddish-purple soils, and are below detection limits in MW-114A and MW-114B. Along the easterly component of groundwater flow toward the Hudson River, lead concentrations are below detection limits at MW-B. Farther east in Geochemical Zone 4, lead concentrations increase slightly to between 15 and 20 µg/L near MW-C and MW-F. The detection of lead in these wells could be a result of modest sources (concentrations no higher than 2,010 mg/kg) in saturated soil, separate from the pyritic material, that could be a result of historical operations at the former Celotex property.

Samples collected during the RI were not analyzed for dissolved lead, however. The results of these analyses may be influenced by undissolved, immobile forms of lead associated with small particulates that reside and accumulate in the well bore and not represent groundwater concentrations..

#### **5.5.4 Ammonia**

Highest concentrations of ammonia in groundwater are located in the intermediate overburden groundwater (above the confining unit) in the northwest corner of the Quanta property (MW-112B) where alkaline pH levels of over 10 have been measured during groundwater sampling. The form of reduced nitrogen is the ammonium cation (positively charged ion) rather than the more volatile ammonia. Concentrations of ammonium and ammonia are equal at a pH of about 9.2 (Hem, 1985). With the exception of monitoring well MW-112B, the pH levels of the groundwater at the Site are less to significantly less than 9; therefore, where detected, ammonium is the dominant form in site-wide groundwater. This isolated and localized geochemical condition in the groundwater at MW-112B indicates a point source of ammonia that probably leaked from a storage tank and further indicates a lack of lateral transport in the vicinity of this well. Ammonia in OU1 groundwater does not travel to the Hudson River via groundwater flow. Microbial activity is an important factor

in the attenuation of ammonia while ammonium is strongly attenuated by ion exchange on clays in the soil, sediments and aquifer. Ammonium is a primary nutrient for microbial activity and growth. The combination of ammonia and TKN data allows an estimate of that activity. Analytical data collected during the supplemental groundwater investigation in October 2006 include both ammonia and TKN. TKN is the sum of ammonia nitrogen plus organic forms of nitrogen. The concentration of organic forms of nitrogen is calculated by subtracting ammonia nitrogen from the TKN. The organic nitrogen is generated by microbial enzymatic processes and, therefore, directly reflects the relative amount of microbial activity in the aquifer. The October 2006 organic nitrogen data (see Table 4-10) indicate that microbial activity contributes an average of 55 percent of the TKN concentration and is fairly consistent amongst the locations sampled. This overall elevated level of microbial activity is a major factor in attenuation of ammonia ammonium in the groundwater.

Ammonium oxidizes to nitrite and then either to dissolved nitrate or to nitrogen gas. In this case, with the significant degradation occurring under very low oxidizing to reducing conditions, the ammonium is probably going directly to nitrogen gas. This conclusion is supported by the distribution of ammonia in groundwater, which indicates attenuation is occurring and controlling the concentration to a level below the lowest applicable screening criteria. Concentrations of ammonia adjacent to the Hudson River are consistently lower than those within the interior of the Site and appear to represent a consistent background concentration of approximately 3,000 µg/L.

### 5.5.5 Pesticides and PCBs

Detections of pesticides in groundwater samples collected during the RI indicate that low levels exist in the interior to the Quanta property, representing isolated noncontiguous groundwater impacts that are the result of historical use of pesticides. Pesticides detected in groundwater above the lowest screening criteria include aldrin, alpha-BHC, heptachlor, 444'-DDD, and 444'-DDE. These constituents have a strong affinity for adsorption to soil and have very low solubility in water. The random distribution of pesticides in groundwater, as well as their chemical characteristics, indicates that pesticides are not mobile in groundwater at the Site. More importantly, however, pesticides are not associated with historical activities at this Site. The detection of these compounds does not reflect Site-related activities but is instead a remnant of historical application.

The PCB Aroclor 1260 was detected at one location in the central portion of the Celotex property (MW-J) during RI groundwater sampling activities with concentrations as high as 6.1 µg/L. The facts that this is an isolated detection and that PCBs are highly insoluble in water and typically considered immobile suggest that PCBs are not being transported via groundwater. These observed impacts are located well to the north of the former operations and are not related to the Site.

## Conceptual Site Model

---

The following conceptual site model (CSM) provides a summary of the Site conditions based on data collected during investigation activities at the Site, as presented in previous sections of this report. This CSM presents the current understanding of the Site characteristics, sources of contamination, migration pathways, and fate and transport of the contaminants. The model is based on interpretation of existing data and is depicted in Figure 6-1. Any additional data collected at or near the Site could result in revisions to the CSM.

### 6.1 Current Land Use

The former Quanta Resources property was bisected in 1995 and 1996 by the realignment of River Road, which now runs north-south through the western portion of OU1. The current 5.5-acre land portion of the Quanta property is a vacant lot. The ground surface is primarily exposed gravel with the remains of concrete tank and building foundations and is sparsely covered with stands of small trees and tall grass.

The Celotex property that borders the Quanta property to the north contains a mixed retail and residency complex, with a parking area on the south portion of the property. South of the Quanta property lies the 115 River Road office complex and the i.Park Edgewater, LLC, (former Lever Brothers) property. A small commercial building is on the northwest corner of the former Lever Brothers property. Block 93 is located to the west of the Quanta property between River Road and Old River Road. Block 93 North contains a small restaurant building. Block 93 Central contains a large multistory abandoned building, and a small abandoned two-story building formerly associated with a railroad in this area. Block 93 South is primarily a parking lot with a small medical building and a municipal pump house building.

### 6.2 Geology and Hydrogeology

Fill material identified throughout the Site is as much as approximately 22 feet thick and consists of silt, sand, gravel, rock, building debris such as concrete and brick, wood, cinders, and slag. Underneath this layer of fill material is approximately 20 feet of fine- to medium-coarse sand. In the western portion of the Site are areas of organic peat up to approximately 15 feet thick. A silty-clay confining layer underlies the shallow sand or peat that acts as a barrier to groundwater and NAPL, and does not constitute a water-bearing unit.

Underneath the silty clay is a deep sand unit up to approximately 25 feet thick, which is unaffected by Site constituents due to the presence of the overlying confining layer. The one area where impacts to the deep sand remain uncertain is in the vicinity of the wooden bulkhead, where low levels of VOCs and select SVOCs have been detected and where NAPL has been observed beneath what is thought to be the silty-clay layer. Further investigation has been proposed in this area as part of the SRI. Bedrock is encountered at the Site at 8.5 to 60 feet bgs with bedrock high in the south-central portion of the former Celotex



property. The following three distinct overburden hydrostratigraphic units exist at the Site above the bedrock surface: the shallow, unconfined water table unit, the silty-clay confining unit, and the deep sand unit.

The direction of shallow groundwater flow is predominately to the southeast toward the Hudson River, with a linear flow velocity of approximately 0.55 foot per day. In general, groundwater flow directions and velocities are not substantively affected by tidal fluctuation of the Hudson River except in the vicinity of a wooden bulkhead located on the Quanta property adjacent to the Hudson River. Here groundwater flow to the Hudson River is impeded significantly. Increased hydraulic heads, in combination with an area of increased localized recharge occurring to the west, forces groundwater to flow radially from the central and western portions of the Quanta property. Groundwater to the south of the Quanta property converges with groundwater originating from the former Lever Brothers property in the northern portion of this property. To the north of the Quanta property, groundwater flows in a more easterly direction toward the Hudson River north of the wooden bulkhead. Groundwater flow direction in the deep sand aquifer is more uniform, running predominately to the east-southeast with linear flow velocities of 0.01 and 0.02 foot per day under low- and high-tide conditions, respectively.

## 6.3 Primary Sources

The primary sources of existing soil and groundwater impacts at the Site include structures and processes associated with the long history of industrial operations at or near the Quanta property.

Within the extent of the former Quanta Resources property, historical operations consisted of coal-tar processing and, subsequently, oil recycling operations. Presumably, leaks from tanks, pipes, or equipment (such as tar stills, oil-water separators, or transformers) throughout the industrial history of the property resulted in the release of various materials, including coal tar. Later, following operational shutdown, periodic Site flooding, seams and valves rusting, pipes and tanks freezing and thawing, and tanks overflowing and resulting in releases as a result of precipitation, as described in the Site Mitigation Work Plan for the Frola/Van Dohln Tank Farm (Weston, 1985). At the time that initial removal actions were proposed, the property had 61 ASTs and up to 10 USTs. The total cumulative storage capacity of the tanks was over 9 million gallons. Together, the releases that occurred during and following active operations at the Site represent primary sources of soil and groundwater impacts associated with the Site. Primary sources related to the Site were removed between 1984 and 1988 during EPA removal actions; however, some buried piping remains in place on the Quanta property.

In addition to coal-tar processing and oil-recycling operations, the operations of a former sulfuric acid plant in the northwest corner of the Quanta property and the southwest corner of the former Celotex property has resulted in the presence of unburned or partially burned pyrite in soils. This primary source is no longer present.

One of the results of the well documented history of heavy industrial activities near the study area (Environ, 2005, a; PMK, 2000; Appendix A) is the contribution of additional primary sources of groundwater and/or soil impacts unrelated to former Site operations to

soil and groundwater impacts within the lateral extent of OU1. These primary sources include the following:

- Import of fill material in the mid-1800s to raise the topographic elevation to develop rail lines and industry along the Hudson River; fill is known to contain significant quantities of coal, coal ash, wood ash, cinders, and slag
- Various releases or incidental spills during historical operations at the former Celotex property, such as metals reclamation, waste oil recycling, gypsum board manufacture, film developing, chemical storage, and vegetable packing and storage
- Manufactured gas plant, filling, and other historical operations at the former Lever Brothers property, which have resulted in several identified AOCs at the property
- Potential releases or incidental spills during loading, off-loading, or other historical operations at the former Spencer Kellogg property
- An unidentified upgradient release of chlorinated solvents
- Former general use of pesticides

## 6.4 Secondary Sources

As a result of some of the primary sources described previously, secondary sources remain present at the Site today and represent continuing sources of impacts to soil and groundwater. These secondary sources include the following.

- NAPL in the subsurface, a continuing source of constituents, primarily aromatic VOCs, PAHs, and select SVOCs, to soil and/or groundwater
- Surface and subsurface soils at various locations throughout OU1 containing VOCs, SVOCs, pesticides, PCBs, and/or metals as a result of Site-related or non-Site-related primary sources
- Undifferentiated hydrocarbon LNAPL on the former Lever Brothers property, a continuing source of organic constituents to soil and groundwater
- Solid tar, a source of VOCs and SVOCs to soil and, to a lesser extent, groundwater
- P/A materials on the former Lever Brothers property, a continuing source of aromatic VOCs, PAHs, and select SVOCs to soil and groundwater
- Unburned or partially burned pyritic ore in the northwest corner of the Quanta property and the southwest corner of the former Celotex property, which oxidizes to produce iron oxide minerals and release impurities to soil and in some cases groundwater from the pyritic ore, such as arsenic, iron, lead, copper, antimony, and thallium
- Areas of concern at the former Lever Brothers property, the source of small areas of PAHs, non-PAH SVOCs, VOCs, metals, and PCBs
- Up to 22 feet of fill material throughout the Site, contributing to the occurrence of PAHs and metals including lead and arsenic in soils and in some cases, groundwater.

## 6.5 Migration Pathways

Primary sources are no longer present at OU1, except for buried piping on the Quanta property. Direct releases to surface and subsurface soil (potentially including soil below the water table) have occurred in the past, as described in Section 6.3. The extent of contamination at the Site is a function of the location of former or current primary sources and the ability of constituents to migrate from the resulting secondary sources in soil and groundwater. Mechanisms that control migration and their effect on contaminants associated with the secondary sources are discussed below.

### 6.5.1 Non-Aqueous Phase Liquid Migration

NAPL at OU1 consists of a wide range of individual constituents, each of which partition differently to other media based on their characteristics. When NAPL is released directly to soil, its migration is controlled by gravity, hydraulic forces, the slope of the surface of any impermeable units, and the characteristics of the bulk NAPL mixture itself (e.g., density). NAPL at the Site is a separate-phase hydrocarbon liquid that is slightly denser than water.

Residual and free-phase NAPL at OU1 occurs in subsurface shallow soils as discrete deposits above, and within the top few feet of, the confining layer. NAPL at most locations within OU1 has reached steady state and is no longer migrating under current conditions.

Under existing conditions, residual NAPL is trapped by capillary forces. The more viscous tars have not migrated vertically beyond a depth of approximately 15 feet bgs. For less-viscous tar that has migrated downward to greater depths in the central and southern portions of OU1, the confining unit and the peat layer (western portion of Site) act as barriers preventing further lateral and vertical migration. Additional investigation at NZ-2 and NZ-5 has been proposed as part of the SRI to address uncertainty regarding potential migration in these shoreline areas and the location and effect of the presence of the wooden bulkhead. The available evidence supports the conclusion that most NAPL in NZ-2 is trapped behind the bulkhead and that NAPL in the area north of the wooden bulkhead (NZ-5) is residual. However, due to the proximity of the NAPL to the Hudson River and the uncertainty regarding the effectiveness of the wooden bulkhead as a barrier to all NAPL movement, the remedial alternative development, evaluation, and selection will conservatively assume that the potential for NAPL migration between OU1 and OU2 should be addressed at both NZ-2 and NZ-5. Additional evaluation of this potential migration has been proposed as part of the SRI.

The potential for altering subsurface conditions that play a role in NAPL mobility is an important consideration for the Site. The effects of future development activities, such as excavation or placement of fill material, placement of subsurface structures, or pumping of groundwater, should be considered when specific development plans have been defined.

### 6.5.2 Advection

Dissolved-phase impacts of SVOCs, metals, ammonia, and PCBs are confined to the shallow fill and native sand deposits above the silty-clay aquitard. The rate of migration of COIs in groundwater is dictated largely by the direction and velocity of the groundwater flow, and constituent-specific attenuation (i.e., retardation) factors, the effects of the latter are

described in the sections below. Dissolved-phase VOCs, PAHs, non-PAH SVOCs, and, to a lesser extent, arsenic migrate in groundwater to various extents before they are attenuated. The rate of transport in groundwater is significantly slower than that of the bulk groundwater flow, and the rate varies based on the retardation of individual constituents. Groundwater in the vicinity of the Site flows radially. Dissolved-phase impacts are predominantly found in the shallow unconfined unit and do not flow to the confined deep sand unit. Eventually, both the shallow unconfined and deeper confined groundwater discharge to the surface water of Hudson River.

### 6.5.3 Partitioning

Partitioning is one of the most important mechanisms influencing the migration of constituents at OU1. Constituents at the Site can be present in NAPL, sorbed to soil, dissolved in groundwater, or present as a gas in soil vapor above the water table. Partitioning between these media is governed by subsurface conditions and by the characteristics of individual constituents.

#### Organic Constituents

At OU1, PAHs are the primary component of NAPL, although non-PAH SVOCs and other organic compounds are also present. PAHs are found sorbed to soil particles above and below the water table. In general, SVOCs including PAHs have low water solubility and increasingly tend to adsorb to soil or particles within groundwater with increasing soil organic carbon. Sorption to soil particles is the primary process responsible for their removal from aqueous systems. Although SVOCs generally do not leach to groundwater because of their strong propensity to adsorb, the amount of PAHs and more soluble non-PAH SVOCs present in the system has overwhelmed adsorption sites.

Dissolved-phase naphthalene and, to a lesser extent, other less-mobile PAHs are migrating in groundwater from OU1 toward the Hudson River. As these PAHs move from OU1 and upward through the sediments in OU2, they are subject to further attenuation and will be at significantly lower concentrations than those measured in the monitoring wells adjacent to the Hudson River at OU1. Upon reaching surface water, these constituents are subject to volatilization and photolysis, resulting in further reduced concentrations. Volatilization from soil might be significant for low molecular weight SVOCs but not for higher-weight SVOCs. However, since Site-related constituents at OU1 have been in place for at least 25 years and potentially up to 130 years, the majority of potential volatilization of SVOCs likely has occurred already. Impervious ground covers (buildings and asphalt) prevent soil gases from escaping to the atmosphere from the vadose zone. Significant volatilization of constituents from surface soil is not expected to occur unless surface soil is disturbed.

Aromatic VOCs such as benzene tend to leach rather than adsorb and, therefore, are found primarily in saturated soil and groundwater rather than in unsaturated soil. Aromatic VOCs such as benzene have a strong tendency to volatilize.

Due to their minimal and sporadic occurrence at low-level concentrations in soil at the Site, chlorinated VOCs transported in soil via leaching or volatilization is not believed to be occurring at any appreciable scale. Chlorinated solvents at OU1 have been detected primarily in groundwater samples collected from the confined deep sand unit; therefore, volatilization of chlorinated VOCs from groundwater to soil vapor and the repartitioning of

these constituents to soil are not anticipated to occur. Low levels of TCE have migrated from offsite sources in the deep sand as far as the wooden bulkhead. Groundwater in this area flows in an easterly direction, eventually discharging to the Hudson River. Upon groundwater discharge to the river, TCE is expected to volatilize rapidly and not be present in surface water or shallow pore water associated with the Hudson River. Quantification of TCE concentrations in the shallow pore water downgradient of OU1 in the Hudson River is proposed as part of the SRI.

PCBs detected at OU1 were present almost exclusively in soil, with only one offsite detection in groundwater. PCBs sorb strongly to soil and generally do not dissolve or leach appreciably. As a result, PCBs at OU1 are found primarily in discrete areas of soil near the ground surface. Although the volatilization rate of PCBs may be low from water and soil surfaces, the total loss by volatilization over time could be significant because of their persistence and stability. In water, a small amount of PCBs might remain dissolved, but most are sorbed to organic particles and, thus, will not migrate in groundwater.

Pesticides have been detected sporadically at OU1; however, the detected pesticides have leached only partially, if at all. Detections of pesticides in groundwater could be a result of constituents adsorbed to saturated soil. The random distribution of pesticides in groundwater, as well as their chemical characteristics, indicates that they are not mobile in groundwater at the Site. No known source of pesticides is at the Site.

## **Metals**

The foremost sources of arsenic and lead within OU1 include the remnants of oxidizing pyrite ore (reddish-purple soils) within the footprint of a former acid plant and the ubiquitous presence of heterogeneous fill material containing slag. The presence of dissolved metals in groundwater, particularly arsenic, is controlled mostly by the redox and pH of the groundwater system and specifically by iron oxyhydroxides and organics (i.e., NAPL), which provide adsorption receptor sites for arsenic and other metals. Groundwater within areas of elevated concentrations of iron, arsenic, or lead in soil and groundwater is slightly oxidizing and acidic, suggesting iron oxyhydroxides are unable to precipitate and redox-sensitive metals such as arsenic will have lower affinity for adsorption.

Concentrations of arsenic within and along the leading edge of plumes indicate that attenuation through adsorption is sufficient to prevent the further expansion of groundwater plumes. Due to their adsorption and immobilization in relatively short distances from source areas, metals downgradient of the source of pyritic material do not migrate to the Hudson River. Additional sources of arsenic can occur close to the Hudson River; however, any arsenic that is not scavenged from groundwater prior to moving from these areas will be subject to further attenuation in OU2. Concentrations of arsenic in surface sediments in the Hudson River adjacent to OU1 are comparable to concentrations in samples collected both upstream and downstream of the Site (CH2M HILL, 2007j).

### **6.5.4 Abiotic and Biotic Transformations**

Geochemical conditions of groundwater indicate microbial activity; thus, biodegradation of organic constituents is occurring at the Site. Biodegradation rates for PAHs, PCBs, and pesticides are limited by their dissolution into the aqueous phase. Adsorbed PAHs and PAHs in NAPL are unavailable to PAH-degrading organisms. Therefore, in areas of residual

and free-phase NAPL, biodegradation is not a significant attenuation mechanism. However, along the leading edge of the dissolved-phase for more soluble constituents such as naphthalene and benzene, microbial processes appear sufficient to stabilize and prevent the further expansion of organic constituents. Biodegradation is not considered to be a significant attenuation mechanism for inorganic constituents at the Site with the exception of Site-related ammonia, which is being attenuated to nitrogen gas under mildly oxidizing to reducing conditions and does not migrate to the Hudson River. SVOCs and VOCs do not generally bioaccumulate. However, inorganics, pesticides, and PCBs will bioaccumulate. The absence of aquatic life at OU1 diminishes the importance of bioaccumulation. Although the plants and trees present at the Quanta property could be bioaccumulating constituents, these plants most likely will be removed during any remedial actions at the Site, and do not represent a significant migration pathway. The ability of aquatic and other organisms to bioaccumulate Site-related constituents identified in OU2 will be evaluated as part of the OU2 RI/FS.

### **6.5.5 Erosion**

Constituents sorbed to surface soil particles might be transported along with the soil particles during the process of erosion, including entrainment in runoff during storm events or in the air under windy conditions. The transport of current Site constituents via runoff or wind transport is minimal because a large majority of OU1 is covered by asphalt, concrete, vegetation, or gravel. However, control of transport via this migration pathway would be an important consideration during any potential construction activities at OU1 that may disturb the existing surface conditions.

## **6.6 Potential Pathways and Receptors**

As a result of the sources and transport mechanisms described, Site-related constituents at OU1 are contained in various media, including surface and subsurface soil, groundwater, and soil vapor. Sediment and surface water in the Hudson River are being evaluated as part of the RI for OU2. When humans or ecological receptors are exposed to these media, constituents present in the media pose risk to the receptors.

### **6.6.1 Ecological Risk Pathways and Receptors**

Based on the location of the Site in an urban area with little or no habitat available for receptor populations, it was determined to be unlikely that many ecological receptors actually inhabit OU1. Without the presence of receptors, the ecological exposure pathway at the Site is incomplete, and no ecological risk is posed by constituents.

### **6.6.2 Human Health Risk Pathways and Receptors**

Five human receptor types were identified with the potential for exposure to one or more media at OU1 potentially containing Site-related constituents. Trespassers/visitors could be exposed to constituents in surface soil under current or future conditions through dermal absorption or ingestion, or to ambient air through inhalation. Commercial workers, daycare children, and residents have the potential to be exposed to constituents in groundwater or surface soil through either ingestion or dermal absorption, and to constituents in ambient and indoor air through inhalation. Construction and utility workers could be exposed to

constituents in groundwater through dermal absorption, to constituents in ambient air via inhalation, or to constituents in subsurface soil through ingestion or dermal absorption.

## Baseline Risk Assessment

---

### 7.1 Human Health Risk Evaluation

The baseline HHRA for OU1 of the Site is presented in Appendix P. The HHRA was prepared in accordance with the requirements of the OU1 AOC. The overall approach and assumptions used in this HHRA are consistent with the AOC for OU1, the EPA-approved RI/FS Work Plan (Parsons, 2005), and the EPA-approved “Pathway Analysis Report (PAR) for the Human Health Risk Assessment – Quanta Resources Site, Operable Unit 1” (CH2M HILL, 2006j), and subsequent comments received from EPA. The objectives of the HHRA were to characterize and quantify the current and potential future risks to human health that could occur if no further remedial action is performed on soil and groundwater at OU1. The methods and approaches used in this HHRA were developed from EPA Risk Assessment Guidance for Superfund (RAGS) (EPA, 1989).

The spatial extent of the HHRA encompasses the majority of OU1, which includes the Quanta property and portions of adjacent properties that might have been affected by former operations. Adjacent properties consist of the former Celotex, 115 River Road, former Lever Brothers, and Block 93 North properties. Potential impacts to Block 93 Central and/or South will be addressed in a future submittal following supplemental investigation in this area. Potential impacts to media in the Hudson River will be assessed in a separate HHRA for OU2.

The initial step in performing the HHRA was to develop a memorandum on exposure scenarios and assumptions, which was submitted to EPA on November 7, 2005 (CH2M HILL, 2005c). The PAR presented the assumptions to be used in the HHRA and was consistent with the memorandum referenced above, with the approach discussed at a meeting conducted with EPA on February 21, 2006, and with EPA comments on the memorandum (received on March 13, 2006). The memorandum included RAGS Part D draft Tables 1 and 4 (EPA, 2001b). The PAR included RAGS Part D Tables 1 and 4 updated on the basis of the meeting held with EPA on February 21, 2006, and EPA comments on the memorandum, in addition to RAGS Part D draft Tables 2, 3, 5, and 6.

In the HHRA presented in Appendix P, the RAGS Part D tables provided in the PAR were updated with additional soil and groundwater data. Specifically, the following information was added to the HHRA:

- Soil analytical data from the former Celotex property
- Soil analytical data from the northwestern corner of the Quanta property
- Groundwater analytical data from RI groundwater sampling events

Following their review of the PAR, EPA provided comments on the PAR (EPA, 2006d), and several meetings were conducted between the CH2M HILL senior risk assessor and the EPA



Region 2 senior risk assessor to address EPA comments on the PAR, and to reach agreements on aspects of the HHRA. Some of these agreements included the following.

- Data groupings used in the HHRA
- Elimination of Class A carcinogenic constituents of potential concern (COPCs) if detected very infrequently and at low concentrations
- Child and youth age-specific exposure factors used to evaluate chemicals with a mutagenic mode of action
- Model and exposure times used to estimate bathroom air concentrations from showering
- Methodology for evaluating potential future indoor air vapor intrusion issues where buildings are not currently located and no specific building plans or specifications exist
- Inclusion of hot-spot evaluations for arsenic in soil and/or groundwater at selected properties based on the distribution of arsenic concentrations
- Methodology for calculating remedial goal options

### **7.1.1 Hazard Identification**

The soil dataset used in the HHRA consists of soil samples collected during the RI and historical soil samples collected at properties adjacent to the Quanta property by consultants under contract with adjacent property owners. The groundwater dataset consists of groundwater samples collected during the RI. Summaries of previous investigations conducted at the Site are presented in Section 1.3.3.

Soil analytical data that were collected from the 0- to 10-foot-bgs interval were used for the HHRA. The available data consist of surface soil samples (0- to 2-foot-bgs interval) and subsurface soil samples (2- to 10-foot-bgs interval) collected between 1990 and 2006. The data were grouped for the HHRA by property and depth, and are presented in Appendix P.

In the HHRA, subsurface soil is evaluated at the 0- to 10-foot depth, which represents the depth of soil assumed for a construction worker to potentially contact. Soil and groundwater data for Block 93 Central and Block 93 South were not available at the time this HHRA was prepared. Risks due to potential impacts at Block 93 Central and/or South will be addressed in a future submittal following supplemental investigation in the Block 93 area. In addition, if necessary, the Block 93 North evaluation presented herein will be updated.

Groundwater analytical data collected during RI activities (2005 and 2006) were used for the HHRA. At the Site, the groundwater data from wells with water present within 10 feet of ground surface were used to quantify potential exposures by a construction worker in a deep excavation. In addition, the potential for future indoor air vapor intrusion exposures by residents was evaluated qualitatively. Groundwater data from the Site were grouped by hydrostratigraphic unit (i.e., above the silty-clay layer and below the silty-clay layer) to quantify hypothetical tap water exposures by future residents, under the assumption that area groundwater would be used as a potable source in the future. However, exposure to

groundwater is not actually a complete pathway for the reasonably foreseeable future. Groundwater at the Site will not be used for potable purposes within a reasonable planning horizon (i.e., 30 years). Moreover, a reliable municipal water supply is readily available; no potable wells are in the vicinity of the Quanta property; water supply planning for the area of the Site does not identify any groundwater supply needs from the vicinity of the Site; and water yield and natural quality of Site groundwater are unlikely to meet potable water use requirements.

At the request of EPA, the shallow groundwater zone was evaluated in the HHRA. Site conditions documented in the RI report indicate that the depth of this zone from the surface to the top of the lower confining level is no greater than 29 feet bgs. In accordance with the NJAC 7:10 et seq. (Safe Drinking Water Act Regulations) and NJAC 7:9D (Well Construction and Maintenance), potable wells will satisfy various requirements based on characteristics for the water-bearing formation. At the minimum, the NJAC requires all casings to be no less than 50 feet in depth, and a minimum length of 50 feet of grout seal extending from the top of the gravel pack or top of the well screen to grade. Therefore, based on conditions observed in the shallow water bearing formation at the Site, a potable well cannot be permitted in accordance with NJAC. As additional safeguards, any deed notification or Classification Exception Area (CEA) identified in the analysis of alternatives for the FS would be expected to address this restriction of use.

The potential receptors at the Site were initially presented in the PAR (CH2M HILL, 2006k). During preparation of the HHRA, the current potential receptors were re-evaluated and revised as appropriate based on existing conditions (Appendix P).

Constituents of potential concern for each environmental medium were identified by a two-step screening process that evaluated frequency of detection and risk-based screening levels. Most chemicals that are considered to be essential nutrients (calcium, magnesium, potassium, and sodium) were not considered COPCs. In accordance with direction from the EPA Region 2 senior toxicologist, because toxicity values are available for iron, iron was evaluated in the same manner as other chemicals that are not essential nutrients. Background concentrations were not considered when identifying COPCs; therefore, some COPCs might be identified as a result of background concentrations being above risk-based screening levels, rather than identified due to Site impacts. COPCs were further evaluated in the HHRA.

Also, a conservative screening of groundwater concentrations in the shallow groundwater (above the confining silty-clay layer) was performed to evaluate potential future indoor air vapor intrusion under a residential scenario. For each chemical detected, the lower of the NJDEP groundwater screening levels for protection of vapor intrusion (NJDEP, 2005) and EPA target groundwater concentrations presented in the OSWER Subsurface Vapor Intrusion Guidance (EPA, 2002a), based on a target excess lifetime cancer risk (ELCR) of  $1 \times 10^{-6}$  and an attenuation factor of 0.001. If the EPA target groundwater concentration is based on a maximum contaminant level (MCL), a value based on carcinogenic effects ( $1 \times 10^{-6}$  ELCR) or noncarcinogenic effects ( $HQ=0.1$ ) was calculated and used in the comparison to the NJDEP screening value.

### 7.1.2 Exposure Assessment

The following potential receptors were identified for existing land uses and were evaluated in the HHRA:

- **Quanta property:** Adult and adolescent trespassers; the Site is inactive and trespassing is expected to be extremely infrequent because the Site is relatively inaccessible to trespassers because of the fence on three sides of the Site (except along the Hudson River) and its elevation above the river.
- **Former Celotex property:** None; the area of the current property that is potentially affected by former Site operations is beneath a paved parking lot.
- **115 River Road:** Commercial workers and daycare children.
- **Former Lever Brothers property:** Adult and adolescent trespassers; the area that is potentially affected by former Site-related operations is inactive, but trespassing might occur because the property is not fenced and is located near developed properties.
- **Block 93 North:** Adult and adolescent trespassers, and commercial workers.

For potential future land uses and activities, each property was evaluated for construction and utility workers, commercial workers, and residents. In addition, at 115 River Road, daycare children were evaluated. Trespassers were evaluated at Quanta property, the former Lever Brothers property, and Block 93 North.

### 7.1.3 Toxicity Assessment

The standard EPA hierarchy of toxicity values was used to identify both cancer and noncancer toxicity values for COPCs for use in the risk calculations. Chemicals with a mutagenic mode of action were evaluated by applying age-dependent adjustment factors to the toxicity values.

### 7.1.4 Risk Characterization

Risk estimates were calculated for various property and existing or future receptor combinations for reasonable maximum exposure and central tendency exposure scenarios. Results are summarized below. Future soil exposure scenarios were based on the assumption that soil currently below concrete or other impervious surfaces is exposed and available for contact. Future groundwater exposures were quantified for construction workers based on the assumption that workers would contact groundwater in deep excavations.

Hypothetical groundwater exposures via potable use (i.e., drinking, showering, and washing) were quantified for future residents at the request of EPA. However, exposure to groundwater is not considered a realistically complete pathway for the future. Site conditions documented in the RI report indicate that the depth of this zone from surface to the top of the lower confining level is no greater than 29 feet bgs. In accordance with the NJAC 7:10 et seq. (Safe Drinking Water Act Regulations) and NJAC 7:9D (Well Construction and Maintenance), potable wells will satisfy various requirements based on characteristics for the water-bearing formation. At the minimum, the NJAC requires all casings to be no

less than 50 feet in depth, and a minimum length of 50 feet of grout seal extending from the top of the gravel pack or top of the well screen to grade. Therefore, based on conditions observed in the shallow water-bearing formation at the Site, a potable well cannot be permitted in accordance with NJAC. As additional safeguard, any deed notification or CEA identified in the analysis of alternatives for the FS will be expected to address this restriction of use.

### **Quanta Property**

Potential cancer and noncancer risks were evaluated for existing and future adult and adolescent trespassers, future commercial workers, construction workers, and adult and child residents. Risks above acceptable levels were calculated for all receptors evaluated.

Although not addressed quantitatively in the risk estimates, residual NAPL is present in soil in some areas of the Quanta property. The depth of the NAPL varies seasonally and could be present at the Site surface during certain times of the year. This residual NAPL will be addressed during future remedial actions.

### **Former Celotex Property**

Potential cancer and noncancer risks were evaluated for future commercial workers, construction workers, and adult and child residents. Acceptable risk levels were calculated for commercial workers. Risks above acceptable levels were calculated for construction workers and residents due to soil and groundwater.

### **115 River Road Property**

Potential cancer and noncancer risks were evaluated for future commercial workers, daycare children, construction workers, and adult and child residents. Acceptable risk levels were calculated for commercial workers. Risks above acceptable levels were calculated for future construction workers and residents due to soil and groundwater.

Risks above acceptable levels were calculated for future daycare children, based on the unrealistic assumption that all existing surface cover (e.g., asphalt parking lot, rubber materials) is removed and the underlying soil is available for contact. This scenario is highly unlikely due to the nature of industrial and commercial building settings and daycare facilities. Exposures associated with the future risk estimates can be avoided by maintaining the surface cover at the Site. Eliminating the potential soil contact points will eliminate the exposure pathways and associated potential risks.

Although not addressed quantitatively in the risk estimates, residual NAPL is present in soil in some areas of the 115 River Road property. NAPL occurs in the shallow fill and sand unit (above the silty-clay confining unit). This residual NAPL will be addressed during future remedial actions.

### **Former Lever Brothers Property**

Potential cancer and noncancer risks were evaluated for current and future adult and adolescent trespassers, future commercial workers, construction workers, and adult and child residents. Acceptable risk levels were calculated for adult trespassers and commercial

workers. Risks above acceptable levels were calculated for adolescent trespassers, construction workers, and residents due to soil and hypothetical groundwater use.

### **Block 93 North Property**

Potential cancer and noncancer risks were evaluated for current and future adult and adolescent trespassers, future commercial workers, daycare children, construction workers, and adult and child residents. Risks above acceptable levels were calculated for all receptors evaluated.

## **7.1.5 Preliminary Remediation Goals**

Preliminary remediation goals were developed where the “remediation triggers” were exceeded (ELCR greater than  $1 \times 10^{-4}$  or a target organ-specific Hazard Index [HI] greater than 1.0 for a receptor) for at least one receptor. If an ELCR of  $1 \times 10^{-4}$  is exceeded, the COPCs that pose an individual ELCR greater than  $1 \times 10^{-6}$  for a receptor/property combination were identified as COCs. If a target organ-specific HI exceeds 1.0, then the COPCs that pose an individual Hazard Quotient (HQ) greater than 0.10 were identified as COCs. For lead, if the predicted blood lead level (BLL) exceeds 5 percent, lead was identified as a COC for that receptor/property combination. PRGs were calculated for surface soil, subsurface soil (2 to 10 feet bgs), and shallow groundwater (within 10 feet of the surface) for COCs.

Remediation triggers were exceeded in soil and shallow groundwater for at least one receptor at the five properties evaluated. Because the assumed future receptors were the same for all properties and the most conservative surface soil scenario is residential, the PRGs for surface soil were based on residential exposure assumptions. The PRGs for subsurface soil and shallow groundwater at all properties were based on exposure assumptions for construction workers.

One set of soil and shallow groundwater PRGs were calculated that can be applied to all five properties. The target risk levels used to calculate PRGs were ELCRs equal to  $1 \times 10^{-4}$ ,  $1 \times 10^{-5}$ , and  $1 \times 10^{-6}$ , and an HQ of 1. The same exposure factor values used in the forward risk calculations were used to calculate PRGs. The residential soil screening level (400 mg/kg) was selected as the lead PRG for surface soil (0 to 2 feet); however, for comparison purposes, the lead PRG for a commercial worker was calculated also using the Adult Lead Methodology (ALM). For subsurface soil, the lead PRG was calculated for a construction worker using the ALM.

For surface soil, PRGs were identified for 10 inorganics, three PCBs, one pesticide, seven carcinogenic PAHs, five SVOCs, and three VOCs. For subsurface soil, PRGs were identified for five inorganics, five carcinogenic PAHs, two SVOCs, and one VOC. Shallow groundwater PRGs were identified for one inorganic (arsenic), six carcinogenic PAHs, two SVOCs (naphthalene and 2-methylnaphthalene), and one VOC (benzene). Lead PRGs were calculated for surface soil and subsurface soil. These PRGs will be used in the FS when evaluating remedial alternatives.

## 7.2 Ecological Evaluation

The SLERA for OU1 was prepared and is included in Appendix Q. Below is a summary of the SLERA. The SLERA was prepared in accordance with the EPA-approved RI/FS Work Plan (Parsons, 2005) and the Exposure Scenario Technical Memorandum (CH2M HILL, 2005c). The SLERA was conducted to evaluate if historical chemical constituent releases at OU1 represent a potential risk to exposed terrestrial flora and fauna. The overall objective of the SLERA is to evaluate if constituents present at OU1 represent a potential risk to ecological receptors.

The methods and approaches used in this SLERA were developed from EPA Ecological Risk Assessment (ERA) guidance (EPA, 1997a and 1998b). In particular, this SLERA consists of Steps 1, 2, and the first part of Step 3 of the eight-step ERA process (EPA, 1997a, 1998b). Step 1 consists of problem formulation; Step 2 consists of analysis and risk characterization; the first part of Step 3 consists of refinement of conservative screening assumptions and refined risk characterization.

The spatial extent of the ERA encompasses terrestrial habitat found on OU1. Potential impacts to aquatic habitat in the Hudson River (OU2) are being addressed separately for that operable unit and not considered in this ERA. The SLERA evaluated potential risk to terrestrial receptors from exposure to compounds detected in surface soil samples collected at OU1. Potential risk was evaluated only for the 5.5-acre Quanta property because neighboring properties are developed heavily with no habitat. Observations of habitat on the Quanta property indicated a disturbed urban old field community with some shrubs and small trees. Portions of the Quanta property are paved, and the overall quality of the habitat is low. No sensitive habitat and no state or federally listed threatened or endangered terrestrial species were identified within a 1-mile radius of the Site. Several birds typically found in urban environments were noted on the Quanta property. No mammals were observed at OU1.

There are no permanent aquatic habitats at OU1. Large puddles were noted on the western and northern sides of OU1 in October 2005 following a period of heavy rain. These puddles were not present in spring and summer 2005.

The potential for ecological risk was evaluated through direct exposure of receptors to soil and by modeling risk from exposure via ingestion of soil and contaminated food or prey items. Media-specific soil-screening values (expressed as concentrations within a media) that are protective of plant and invertebrate communities were used to evaluate risk from direct exposure to chemicals in surface soil. Using conservative exposure scenarios, potential risk was indicated for plant and invertebrate receptors from exposure to concentrations of metals, SVOCs, and VOCs in soil.

Risk to higher-order receptors was evaluated via the ingestion pathway using food-chain models to estimate an exposure dose. The estimated dose was compared to reference toxicity values to evaluate potential risk. Higher-order receptors that were evaluated via food-chain exposure included several small mammals (shrew, vole, mouse, and weasel), raccoon, red-tailed hawk, and American robin. The initial SLERA food-chain models indicated potential risk to one or more of the higher-order receptors from exposure to metals, PCBs, and SVOCs in food or prey items.

In order to evaluate exposure to upper-trophic-level receptors from the puddles observed in October 2005, four water samples were collected from the puddles and analyzed for VOCs, SVOCs, pesticides, PCBs, metals, and ammonia. Five pesticides were detected at low concentrations ( $< 0.5 \mu\text{g/L}$ ). PAHs were detected in three of the four samples, with fluoranthene detected at the highest concentration ( $110 \mu\text{g/L}$ ). Analytical results are provided in Table F-7 in Appendix F.

At the completion of the SLERA (Step 2), several COPCs were identified in soil that could pose risk via direct contact or food-chain exposure to terrestrial receptors at OU1. As specified by EPA guidance, the SLERA was completed using conservative assumptions. To provide additional perspective on the indicated risk, the screening and food-chain modeling was re-done, using less-conservative assumptions (Step 3 of the ERA process). For example, mean concentrations of Site constituents were used in the screening and modeling instead of maximum concentrations. Mean, median, or midpoint exposure factors were used in the food-chain models instead of maximum values (i.e., mean instead of maximum ingestion rate).

Using refined assumptions, direct exposure risk was indicated for plant and invertebrate receptors based on exposure to metals, SVOCs, and VOCs in soil. The list of direct exposure COPCs was reduced in number using the refined assumptions.

The refined food-chain modeling indicated the potential for risk for the shrew, white-footed mouse, and the meadow vole from exposure to PCBs and PAHs in food and prey items. Food-chain risk was not indicated for the avian receptors or the raccoon, using the less-conservative model inputs.

The results of this SLERA and the Step 3 refinement work indicate the potential for risk, but include many conservative assumptions and uncertainties. Uncertainties associated with this SLERA include a lack of site-specific data, such as chemical form and bioavailability, actual occurrence of selected receptors at the Site, and use of literature-based toxicity values instead of site-specific toxicity or tissue data. To address uncertainty, additional studies and data collection could be completed at OU1. However, based on the location of this Site in the center of a very urban area, actual habitation of OU1 by many receptors is unlikely. The expectation that OU1 will be remediated and most likely developed precludes the need for additional characterization of ecological risk, especially when ecological receptors might not permanently inhabit OU1, and little to no habitat is expected to exist after development.

Based on recent adjacent property redevelopment, community growth, community and land owner interests, redevelopment is expected, but no plans have been announced publicly to date. Potential ecological risk identified in this risk assessment will be considered in the FS process, as appropriate.

CH2M HILL received EPA comments on the Draft SLERA on July 7, 2006. EPA agreed with the overall conclusions of the SLERA, agreed that additional characterization of ecological risk at OU1 was not necessary, and agreed that a Baseline Ecological Risk Assessment would not be required for OU1. EPA made several comments concerning the SLERA and asked that these comments be addressed and incorporated into the final SLERA submitted as part of the RI. A response to these comments was provided to EPA on August 30, 2006. The revised SLERA addressing these comments is attached as Appendix Q.

## Summary and Conclusions

---

Findings and conclusions, based on the information and data evaluations presented in this report and previous reports available for OU1 and the surrounding properties, are discussed below.

### 8.1 Site Setting and Background

Operable Unit 1 of the Site consists of the current Quanta property (Block 95, Lot 1, between River Road and the Hudson River bulkhead), portions of the former Celotex property to the north, the 115 River Road property, portions of the former Lever Brothers property, a portion of River and Gorge roads, and portions of Block 93 North, Central, and South.<sup>21</sup> The total land area of OU1 encompasses approximately 23 acres. A tidally influenced mud flat or marsh associated with the Hudson River borders OU1 immediately to the east of the wooden bulkhead. These river sediments consist of silt to clayey silt greater than 50 feet thick immediately east of the bulkhead. Impacts to sediment and surface water are being addressed under a separate Administrative Order on Consent for OU2 of the Site.

Prior to the mid-1800s the Site and surrounding areas were tidal marshlands associated with the Hudson River. Development of rail lines and industry along the banks of the Hudson River prompted the systematic infilling of these marshlands. Fill material during this timeframe is known to have contained coal, coal ash, wood ash, cinder, and slag. This fill material contains varying concentrations of PAHs and metals that can often exceed regulatory soil cleanup criteria and contribute to groundwater impacts. From approximately 1872 to 1971, a large portion of the Site was used to process coal tar and to produce paving and roofing materials. In 1974, a portion of the Site was reoccupied and leased for oil recycling, which continued until NJDEP prohibited facility operations in 1981.

### 8.2 Site Geology and Hydrogeology

Soil impacted by former Site operations consists predominantly of fill material and deposits of native sand and peat in contact with shallow groundwater. These units are underlain by a silty-clay confining layer at a depth of approximately 10 to 30 feet bgs, ranging in thickness from 10 to 25 feet. A confined water-bearing “deep sand” unit lies between the aquitard (confining unit) and the bedrock surface. This deeper sand unit is approximately 7 to 25 feet thick, extending laterally to near the edge of the Hudson River and vertically to the bedrock surface, which ranges in depth from 8.5 to 60 feet bgs.

The direction of the shallow unconfined groundwater flow is generally to the east and south, with an area of radial flow on the Quanta property. Flow direction remains consistent between daily tidal events (low and high tides); however, the hydraulic gradient is slightly

---

<sup>21</sup> Further delineation of OU1 in the vicinity of Block 93 has been proposed in the second RI/FS Work Plan Addendum for OU1, the results of which will be evaluated prior to remedy implementation.



steeper during low-tide conditions. A tidal response has been observed in monitoring wells adjacent to the Hudson River outside the area of a wooden bulkhead present at the Quanta property that is serving as a hydraulic barrier. Groundwater within the deep sand hydrostratigraphic unit flows more uniformly toward the east-southeast. Groundwater elevations in the deep sand hydrostratigraphy unit are influenced more readily by tidal conditions than are those in the shallow hydrostratigraphic unit.

The radial groundwater flow pattern in shallow unconfined groundwater is the result of localized recharge associated with low-lying unpaved areas in the central portion of the Quanta property and the presence of the wooden bulkhead, which is impeding groundwater flow to the Hudson River from OU1. The effect of this barrier is evidenced in the dampened tidal influences and consistently higher hydraulic heads observed at monitoring wells behind the bulkhead compared to those measured in monitoring wells to the north and south.

South of the Site, an area of groundwater convergence has been observed consistently near the central to northern portion of the former Lever Brothers property. At this location, shallow unconfined groundwater from the central portions of the former Lever Brothers flows to the northeast and converges with groundwater flowing from the Quanta property.

In the deep sand unit, hydraulic heads are consistently higher than those observed in collocated wells screened at the base of the unconfined shallow groundwater zone. The vertical hydraulic gradients measured between the unconfined and deep sand units remain upward during high- and low-tide conditions and confirm that the two units are not connected hydraulically.

Historical groundwater flow patterns may have differed from those observed during RI activities. However, determining historic groundwater flow patterns constitutes an uncertainty that cannot be resolved. The most appropriate approach to understanding groundwater flow at the Site is to use data obtained as part of the RI.

## 8.3 Sources

Sources of Site-related constituents have been identified and characterized. Primary sources of these constituents are no longer present, except for buried piping on the Quanta property. These sources were associated former coal-tar processes from approximately 1872 to 1971 and, subsequently, oil-recycling operations until 1981. As a result of historical activities, secondary sources remain at the Site today in the form of NAPL, solid tar, unburned or partially burned pyrite ore, and soil containing PAHs, non-PAH SVOCs, aromatic VOCs, and other constituents.

The preferential pathways evaluation demonstrated that although pipes of various sizes and materials of construction exist in the subsurface at OU1, none of the pipes investigated are currently acting as preferential pathways for the migration of NAPL or other COCs to OU2 or offsite. No evidence of a discharge pipe or drain associated with the oil water separator as described in the RSI was observed in preferential pathways excavation P-1 or P-2, which were located where the former oil water separator pipeline was depicted in Figure 2-5 of the RSI. Furthermore, no evidence of an oil water separator pipe or drain has been observed

during field utilities surveys conducted above or below the overhanging concrete pier or during any other field work during the RI.

Additional secondary sources of groundwater and/or soil constituents unrelated to OU1, but within its extent include AOCs and LNAPL on the former Lever Brothers property, an unidentified upgradient source of chlorinated solvents in deep sand groundwater, PCBs in soil on adjacent properties, and metals and PAHs in soil associated with former railroads or other non-Site-related historical operations including historical filling.

## 8.4 Nature and Extent

To develop a comprehensive understanding of the nature and extent of Site-related constituents and to define the boundaries of OU1, this RI report compiled 3,600 soil analyses and data from 57 groundwater-monitoring locations, NAPL fingerprinting and physical characteristics data, TarGOST® coal-tar delineation results, and soil vapor, as well as indoor/outdoor air analyses and building surveys. Based on this comprehensive data set, the extent of NAPL was defined, and specific COIs were developed for soil and groundwater. COIs were identified by screening analytical results against the lowest available soil and groundwater screening criteria between EPA Region 9 PRGs (residential soil, industrial soil, and groundwater), proposed New Jersey soil cleanup criteria (residential, nonresidential, and impact-to-groundwater),<sup>22</sup> and promulgated New Jersey groundwater quality criteria (or interim generic values).

### 8.4.1 Nature and Extent of NAPL and Solid Tar

The location, nature, and extent of free and residual NAPL at OU1 have been characterized using analytical data and field observations, and have been refined using TarGOST®. The extent of solid tar has been defined using field observations. Residual and free-phase NAPL occurs in shallow soils in discrete areas above and on top of the silty-clay confining layer. Coal tar impacts extend beyond the lateral extent of NAPL in the form of staining or odors, as depicted in Figure 4-1.

With the exception of LNAPL at MW-7 on the former Lever Brothers property, NAPL samples collected were identified through chemical analysis as consisting of coal tar. Variances in the physical properties of the NAPL samples suggest that the properties have varying degrees of mobility in the subsurface under current conditions. With the exception of the NAPL detected to the south at monitoring well MW-107, the NAPL at OU1 has relatively elevated measured viscosity and interfacial tension indicating a lower propensity for the NAPL to migrate. These data support field observations that indicated that NAPL at select monitoring wells was “thick” and difficult to penetrate with sampling and measurement devices.

NAPL with higher viscosity and interfacial tension does not extend to the top of the silty-clay confining unit but remains trapped just below the water table and is no longer migrating laterally or vertically. Lower-viscosity NAPL appears to have migrated to the

<sup>22</sup> Data were screened against the NJDEP soil cleanup criteria available in March 2007. Cleanup criteria were changed and repropose by NJDEP in May 2007. There are currently no promulgated soil cleanup criteria for New Jersey.

depth of the silty-clay confining layer and has settled into natural depressions along the surface of this unit, where the NAPL can no longer migrate vertically or horizontally.

Extensive characterization has revealed that the majority of NAPL at the Site is present as part of one of four discrete NAPL zones (NZ-1, 2, 3, and 4). An additional zone (NZ-5) was identified based on its proximity to the Hudson River and on the need to evaluate these impacts for the purpose of the remedy selection process. The NAPL zones are depicted in Figure 4-4. Although NAPL exists in areas outside these defined zones, these areas are generally characterized by the presence of residual NAPL only, or thin discontinuous pockets of free-phase NAPL.

Solid tar has been observed in several soil borings at the Site, most frequently in the form of a black, soft to stiff, semiplastic to plastic material at discrete depth intervals with a thickness ranging from 0.3 foot to approximately 6 feet. Surficial tar boils have been observed in areas similar to that of the solid tar.

#### **8.4.2 Nature and Extent of COIs in Soil**

Constituents of interest detected in soil include SVOCs (predominantly PAHs), aromatic VOCs, and metals (e.g., arsenic and lead). COIs identified less frequently include chlorinated VOCs, pesticides, and PCBs.

Consistent with previous soil sampling events in and around the Site, soil samples collected during RI activities indicate the presence of PAHs in unsaturated and saturated soil throughout the Site. PAHs were not detected above the screening criteria in soil samples collected from the deep sand unit beneath the silty-clay aquitard. Exceedances of aromatic VOCs, particularly benzene, in unsaturated soils appear to lie within the extent of the historical Site operations, while the extent of benzene in saturated soil extends slightly farther to the south, outside the footprint of former operations, in the direction of groundwater flow.

In general, the distribution of PAHs, aromatic VOCs, and other NAPL-related constituents (e.g., select non-PAH SVOCs) was observed to be coincident with the presence of NAPL and other observed sources unrelated to Site operations. However, concentrations of PAHs and metals unrelated to former Site operations have been observed consistently above screening criteria outside these affected areas.

The two most significant sources of elevated arsenic and lead identified within the extent of OU1 is pyritic material associated with the former acid plant that once operated in the northwest portion of the Quanta property and at the former Celotex property, as well as ubiquitous heterogeneous fill containing coal, cinders, and slag. The extent of elevated arsenic concentrations in soil near the site of the former acid plant has been defined and does not extend beyond the southwestern portion of the former Celotex property and northwestern corner of the Quanta property. The extent and distribution of lead in soil has been defined and is different than that of arsenic. The distribution of lead is more widespread at the former Celotex property.

Pesticides in soil within OU1 represent isolated non-contiguous release scenarios that are the likely result of historical use of pesticides. Detected concentrations of PCBs in soil above the EPA Region 9 Residential PRGs of 0.22 mg/kg are found occur as discrete limited areas

on each of the properties, primarily in the vadose zone. The detected PCB concentrations exceeding applicable screening criteria in the saturated zone, deeper soils are limited and present as isolated to five sample locations in four isolated areas.

### 8.4.3 Nature and Extent of COIs in Groundwater

Constituents of interest identified in groundwater consist primarily of SVOCs (predominantly PAHs), aromatic VOCs, arsenic, lead, iron, ammonia, and, to a lesser extent, chlorinated VOCs, pesticides, and PCBs. The extent of Site-related constituents in groundwater is depicted in Figure 4-41, and includes areas on the Quanta, 115 River Road, former Lever Brothers, former Celotex, and Block 93 North and Central properties.

Naphthalene and benzo(a)pyrene were selected as representative PAHs at OU1. The extent of naphthalene in groundwater extends farther downgradient from known areas of NAPL than the extent of benzo(a)pyrene. In general, naphthalene in groundwater covers an area similar in shape and slightly greater than the portion of the Site at which evidence of NAPL has been identified (except where offsite sources of naphthalene are present). Similarly, the extent of dissolved-phase benzo(a)pyrene is limited to within the total lateral extent of NAPL, again, with the exception of areas where offsite sources are present.

With the exception of naphthalene and benzo(a)anthracene, PAHs were not detected above applicable screening criteria in any groundwater samples collected from monitoring wells screened in the deep sand unit, indicating that the presence of most dissolved-phase PAHs is confined to the shallow fill and native sand deposits above the silty-clay aquitard. The extent of non-PAH SVOCs at OU1 are similar to the extent of PAHs and are located within the maximum detected lateral extent of naphthalene and benzo(a)pyrene.

Non-PAH SVOCs at OU1 consist primarily of phenolics (e.g., phenol and 2,4 dimethylphenol), dibenzofuran, and carbazole. Non-PAH SVOCs exceeded the applicable groundwater screening criteria in a lower percentage of RI groundwater samples than PAHs and are found primarily in the central portions of the Site. The extent of non-PAH SVOCs does not extend beyond the footprint of the naphthalene plume.

The distribution of benzene, a representative aromatic VOC, in groundwater is consistent with the known distribution of Site-related NAPL. However, with a greater solubility in groundwater and a lower screening criterion, benzene exceedances in groundwater extend farther hydraulically downgradient of NAPL sources than naphthalene. The footprints of other Site-related VOCs in groundwater at OU1 are located within the lateral extent of benzene.

Although chlorinated VOCs were detected in the deep sand groundwater, the lateral and vertical distribution of these compounds throughout the Site, as well as the relationship of hydraulic heads between the shallow unconfined and deep sand units, indicates that the source of these chlorinated VOC impacts is not the result of a release or releases related to Site-specific historical operations. Sporadic lower-level detections were observed in groundwater within the footprint of the Site-related impacts, as well as in offsite areas.

The presence of arsenic and iron in groundwater is a function of the relationship between redox potential (measured by ORP) and pH conditions in groundwater, which in turn are affected by the presence of organic material such as NAPL. Figure 4-39b depicts the location

of reddish-purple soil, coal tar, and arsenic in groundwater. Due to source characteristics and the sensitivity to changes in groundwater geochemistry, the distribution of detected arsenic and iron at and adjacent to the Site appear as are four distinct areas. Thus, concentrations of arsenic greater than 1,000 µg/L have been identified in groundwater at OU1: (1) Block 93 near MW-111, (2) near the former acid plant in the northwest portion of the Quanta property and the southwestern portion of the Celotex property, (3) the northern portion of the former Lever Brothers property near MW-107, and (4) the central portion of the former Lever Brothers property near the former P/A material area.

Due to differences in the nature and extent of the pyritic sources versus that of the regional fill material, and because lead, unlike arsenic, is not redox sensitive and is expected to be relatively immobile at the Site, the distribution of lead in groundwater is distinctly different than that of arsenic and iron. Thus, the portions of the Site where lead concentrations greater than 50 µg/L are almost exclusively within the footprint the former acid plant.

Concentrations of ammonia exceeding groundwater screening criteria do not extend downgradient as far as the Hudson River. The distribution of ammonia concentrations observed in groundwater is consistent with the location of previous storage areas as identified on historical maps, and suggests the source of these detected constituents is related to the former coal tar operations. The highest concentration of ammonia in OU1 groundwater was detected in a sample collected from monitoring well MW-112B on the northwestern portion of the Quanta property.

Groundwater sampling results indicate that low concentrations of pesticides were detected within the interior portions of the Quanta property. These concentrations represent isolated, noncontiguous groundwater concentrations that are the result of the historical use of pesticides. The PCB Aroclor 1260 was detected at one location in the central portion of the Celotex property (MW-J) during RI groundwater sampling activities. Because PCBs adsorb strongly to soils and have not been detected in groundwater between the Quanta property and MW-J, this observed concentration is not considered related to Site operations.

#### **8.4.4 Extent of OU1**

The extent of OU1 has been defined (as shown in Figure 4-41), incorporating the observed extent of NAPL and Site-related constituents detected in soil and groundwater. The lateral extent of OU1 has been expanded to include the HCAA.<sup>23</sup> The northern boundary of OU1 is defined by the extent of Site-related NAPL and COIs in subsurface soils and groundwater, as well as by the HCAA. The southern boundary of OU1 is the extent of dissolved-phase Site-related constituents and the groundwater convergence area in the northern portion of the former Lever Brothers property. To the west, the delineation of the definitive extent of Site-related impacts has been proposed as part of the SRI; however, the extent of detected Site-related constituents in this area (Block 93 Central and South) appears to be limited to the eastern portions of these properties. The eastern boundary of OU1 is administratively

---

<sup>23</sup> The High Concentration Arsenic Area (HCAA) is defined by the extent of reddish-purple soils or where concentrations or arsenic in soil exceed 1,000 mg/kg. At the Quanta property this is based on visual observations and analytical data associated with historical investigations as well as more recent RI soil investigations. For the former Celotex property the extent of the HCAA was depicted as the extent of the impermeable arsenic liner, which was designed and built to include concentrations of arsenic in soil in excess of 1,000 mg/kg.

defined as the wooden bulkhead on the Quanta property and portions of the shoreline to the north and south of the bulkhead.

With the following exceptions, the vertical extent of Site-related constituents extends from the ground surface to a maximum depth of the top of the silty-clay confining unit. Shallow soil (0 to 2 feet bgs) in several areas within the horizontal extent of OU1 does not contain Site-related constituents.

- Soil currently within the interval of 0 to 2 feet bgs on the Celotex property is above the water table and consists entirely of fill material imported during recent property redevelopment.
- Soil within the range of 0 to 2 feet bgs on the former Lever Brothers property and the Block 93 South property is above the water table and does not contain Site-related constituents. Buildings and other surface improvements on these properties associated with historical operations physically would have prevented the migration of surface soil from Site to these properties.
- Limited detections of constituents in soil identified within range of 0 to 2 feet bgs on the Block 93 Central property are most likely a result of rail activity and loading and unloading associated with former Spencer-Kellogg operations. However, minor erosion may have resulted in incidental transport of Site-related constituents to Block 93 Central.
- Soil within the range of 0 to 2 feet bgs depth range within the footprint of River and Gorge Roads is above the water table and consists of fill material imported during road construction in the 1990s.

## 8.5 Fate and Transport

Relevant fate and transport processes controlling the migration of COIs at the Site have been evaluated and are understood sufficiently to allow development of remedial alternatives.

### 8.5.1 Fate and Transport of NAPL

The potential for migration of NAPL varies between the defined discrete NAPL zones based on the varying physical characteristics (e.g. viscosities, densities, and interfacial tensions) of NAPL samples collected across these areas as well as the physical characteristics of the subsurface. NAPL migration under current conditions has been evaluated for each of five NAPL zones (shown in Figure 4-4):

- In NZ-1, high viscosity and interfacial tension have generally limited the downward vertical migration of NAPL to a maximum depth of 11 feet bgs. At an isolated area (the vicinity of MW-102B and SB-9), NAPL has migrated to the depth of the silty-clay confining unit, approximately 25 feet bgs. Further migration of NAPL in this zone is not predicted to occur, based on the physical characteristics of the NAPL and the likely age of release(s) that resulted in the presence of NAPL at this location. At MW-102B and SB-9, further migration is prevented by the presence of the silty-clay confining unit.
- In NZ-2, the high viscosity and interfacial tension have generally limited the migration of NAPL to approximately 14 feet bgs. The physical properties of the NAPL in this zone

support the prediction that further migration under current conditions is unlikely. A discrete interval of deeper NAPL below NZ-2 was also observed from 24 to 25 feet bgs at MW-116DS. In light of the remaining uncertainty in this area, particularly with regard to the deeper NAPL observed at MW-116DS and the unknown vertical extent of the wooden bulkhead, additional investigation in the vicinity of NZ-2 has been proposed as part of the SRI. Due to these remaining uncertainties, the remedial alternative development, evaluation, and selection conservatively assume that the potential for NAPL migration between OU1 and OU2 should be addressed at NZ-5.

- NZ-3 consists of deeper NAPL in the central portion of the Quanta property, extending across the 115 River Road property onto the northern portion of the former Lever Brothers property. NAPL in NZ-3 is more mobile and has migrated downward and laterally to a natural depression in the top of the silty-clay confining unit at approximately 25 feet bgs. Gravitational forces and the impermeability of the confining layer prevent further downward and lateral migration of NAPL in this zone.
- NZ-4 comprises shallow and deeper NAPL beneath Block 93 Central, Block 93 South, River Road, and the northwestern portion of the former Lever Brothers property. Potential migration of NAPL in NZ-4 will be determined through the completion of the proposed additional delineation work in this area (CH2M HILL, 2008a).
- NAPL at NZ-5 was identified in borings and by TarGOST® adjacent to the Hudson River between 18 and 25 feet bgs, and further west on the former Celotex property. The available evidence supports the conclusion that most NAPL in this area is residual. However, due to the proximity of the NAPL to the Hudson River, the remedial alternative development, evaluation, and selection conservatively assumes that the potential for NAPL migration between OU1 and OU2 should be addressed at NZ-5.

The potential for altering subsurface conditions that play a role in NAPL mobility is an important consideration for the Site. The effects of future development activities, such as excavation or placement of fill material, placement of subsurface structures, or pumping of groundwater, should be considered when specific development plans have been defined.

## 8.5.2 Fate and Transport of Constituents of Interest in Soil

Two major mechanisms exist for the transport of COIs in soil at the Site—leaching and volatilization. Erosion, degradation, and bioaccumulation play less significant roles in the transport of COIs in soil at the Site.

Although SVOCs (including PAHs) at OU1 generally adsorb strongly to soil particles and do not leach significantly, characteristics of the sources (i.e., NAPL) present in the subsurface and the length of time they have been present have resulted in the dissolution of SVOCs into groundwater over the Site at levels exceeding applicable screening criteria. Since Site-related constituents have been in place for the past 25 to 130 years, it is assumed that the majority of volatilization of these constituents has already taken place, and that significant volatilization of SVOCs from surface soil is not expected to occur unless surface soil is disturbed.

Aromatic VOCs at the Site, such as benzene, have leached from the soil to the groundwater. Benzene has a low affinity for adsorption; therefore, leaching has resulted in a large area of

benzene in the saturated zone, compared to a relatively small area of benzene in the unsaturated zone.

Two distinct sources of metals are at the Site—the former acid plant and fill material. A distinct mineralogical difference exists between the brown-black fill and the reddish-purple soils within the footprint of the former acid plant. The reddish-purple soils include unburned or partially burned pyrite that is continuing to oxidize, ultimately producing reddish iron oxide minerals and elevated concentrations of iron along with metal impurities of the ore, such as arsenic, lead, copper, antimony, and thallium. In the slag-rich fill, the transport of metals in unsaturated soils is controlled by the adsorption and desorption of these metals to and from soil during the infiltration of rainwater. Fill samples were tested using SPLP and were found to leach antimony, arsenic, copper, iron, and lead.

Pesticides and PCBs are present in limited areas of OU1 and adsorb strongly to soil particles, limiting their downward migration and transport in groundwater.

Significant additional migration of COIs in soil at OU1 is not expected to occur. Dissolved phase constituents are at equilibrium with all of the sources, including NAPL. Limited infiltration and surface improvements prevent volatilization, erosion, leaching, or degradation from becoming significant transport mechanisms for COIs in unsaturated soil.

### 8.5.3 Fate and Transport of Constituents of Interest in Groundwater

Adsorption and degradation reactions are the most dominant attenuation factors for the fate of groundwater constituents at the Site.

Concentrations of constituents in groundwater are generally constant over time. The footprint of the composite extent of groundwater impacts is not expanding beyond its current boundary under current conditions, as evidenced by concentration versus time plots and plots of groundwater plumes over time for key constituents. The more mobile dissolved-phase constituents in groundwater (benzene and naphthalene) have not migrated hydraulically downgradient beyond approximately 175 feet of the defined extents of Site-related NAPL. As dissolved-phase COIs move from source areas at OU1 adjacent to the Hudson River upward through the sediments in OU2, they are subjected to further attenuation.

Arsenic in each of the distinct areas of concentrations greater than 1,000 µg/L in groundwater are a function of the source of arsenic and groundwater geochemistry in the vicinity of localized sources. Likely sources of the arsenic include pockets of slag and cinders related to fill or the presence of pyritic material within the footprint of the former acid plant (the northwest portion of the Quanta property and the southern portion of the former Celotex property).

The most important attenuation mechanism for arsenic in groundwater is its adsorption to iron oxyhydroxides, which exhibit a strong affinity and high capacity for arsenic adsorption. Site-specific geochemical data within the elevated arsenic areas indicate that arsenic has been reduced to the more mobile species arsenite and conditions are not suitable for the precipitation of key minerals (iron oxyhydroxides) that serve as the adsorption sites for the arsenic. In these geochemical areas where sources of arsenic, such as pyritic material and fill material, are present or just upgradient, elevated concentrations of arsenic in groundwater



are observed. However, downgradient of source zones, geochemical conditions change such that the negatively charged forms of arsenate are the more dominant species, and iron oxyhydroxide precipitation is favored. At these geochemical transition zones, adsorption more readily occurs, resulting in the immobilization of arsenic in groundwater.

Concentrations of arsenic within and along the leading edge of the detected groundwater concentrations associated with each of the high-concentration arsenic areas indicate that attenuation through adsorption and mineral precipitation is sufficient to stabilize and prevent further migration of arsenic beyond where it is observed. Arsenic near the former acid plant attenuates in groundwater through adsorption and does not migrate to the Hudson River. However, additional sources of arsenic related to fill have contributed to the presence of dissolved-phase arsenic concentrations adjacent to the Hudson River. Arsenic that is not scavenged from groundwater prior to moving from these areas would be subject to additional attenuation in OU2.

In general, lead is strongly adsorbed under a wide range of pH and Eh conditions and would not be transported readily in groundwater. Due to the relative immobility of lead, elevated concentrations of lead do not persist in groundwater downgradient to the south or east of the source because lead is adsorbed quickly to organics or hydroxide minerals, or it is precipitated. Lead associated with the former acid plant attenuates in groundwater through adsorption and does not migrate to the Hudson River. Farther downgradient, concentrations increase slightly as a result of more modest sources in saturated soil that are separate from the pyritic material and could be a result of historical operations at the former Celotex property.

The random and isolated occurrences of pesticides in groundwater, as well as their chemical characteristics indicate that pesticides are not mobile in groundwater at the Site. PCBs were detected in groundwater in one location, the central portion of the former Celotex property, and are unrelated to former Site operations. Similar to pesticides, the characteristics of PCBs and the isolated occurrence in groundwater indicate that PCBs are not transported in groundwater.

Ammonia in OU1 groundwater does not discharge to the Hudson River. Although concentrations of ammonia above screening levels are present, adsorption and microbial activity act to attenuate these impacts such that concentrations in groundwater adjacent to the Hudson River are below screening criteria.

## 8.6 Risk Assessment

An HHRA was conducted for the majority of OU1 (with the exception of River and Gorge Roads, Block 93 Central, and Block 93 South) and has identified COCs for three media:

- Surface soil (0 to 2 feet bgs)
- Subsurface soil (0 to 10 feet bgs)
- Groundwater (above and below the silty-clay confining layer)

Existing potential receptors identified in the HHRA included trespassers, commercial workers, and daycare children. For potential future land use, receptors included construction/utility workers, commercial workers, daycare children, trespassers, and

residents. Risks above acceptable levels for one or more existing or future receptors as a result of exposure to soil or groundwater were calculated on all properties evaluated. The primary risk drivers at the Site are carcinogenic PAHs, naphthalene and arsenic. Along with these primary risk drivers, surficial tar boils identified during the RI will be addressed during future remedial actions.

Studies of potential vapor intrusion pathways have been conducted at buildings at the 115 River Road, Block 93 North (former Jono's Restaurant), and the former Lever Brothers property (Building 9). These studies have included groundwater, subslab and indoor air sampling, physical observations of the buildings, and measurements of air pressure within buildings. The results from these studies conclude that the vapor intrusion pathways are unlikely to be present or are of a sufficiently small magnitude such that they do not pose an unacceptable human health risk to the occupants of these buildings under current conditions.

A SLERA completed for OU1 evaluated potential risk to terrestrial receptors from exposure to compounds detected in surface soil on the 5.5-acre Quanta property. Potential ecological risk was evaluated through direct exposure to soil and via the food-chain exposure pathway. Using conservative exposure scenarios and assumptions, risk was indicated to plant and invertebrate receptors via direct exposure and to higher-order receptors exposed to contamination through the food chain. The SLERA was refined using less-conservative assumptions, which reduced the number of compounds indicating potential risk from direct exposure and limited the higher-order receptors at potential risk to small mammal species. Based on the location of the Site in an urban area with limited and poor quality habitat available for receptor populations, inhabitation of OU1 by these receptors is unlikely. In the July 7, 2006, comments on the SLERA, EPA agreed with the overall conclusion that additional characterization of ecological risk at OU1 was not necessary.

## 8.7 Recommendations

Sufficient characterization of OU1 has been conducted and appropriate data evaluations have been performed to support remedy decisions for OU1. To the west, the definitive extent of Site-related impacts will be determined as part of the SRI. However, the conditions in these areas are not expected to materially affect the remedial technologies and/or remedial alternatives developed and evaluated in the FS, but could change the extent of areas to which selected remedial actions will be applied.

Based on the RI findings, the FS for OU1 should evaluate technologies and develop and screen remedial alternatives to

- Reduce existing and/or potential future human health risks to acceptable levels at the properties that comprise OU1, including limiting potential future contact with NAPL
- Prevent erosion, transport, or migration of COCs in soil or groundwater offsite or to OU2 at concentrations resulting in human or ecological risk above acceptable levels

## References

---

Advanced Applied Technology Development Facility. 1997. "Technology Practices Manual for Surfactants and Cosolvents."

ASTM (American Society for Testing and Materials). 2000. Standard Practice for Description and Identification of Soils (Visual-Manual Procedure). ASTM Method D2488-00.

ATSDR (Agency for Toxic Substances and Disease Registry). 2007. ToxFAQ™ Toxicological Information Fact Sheets. U.S. Department of Health. <http://www.atsdr.cdc.gov/toxfaq.html>. Accessed July 25, 2007.

Bakermans, C., A.M. Hohnstock-Ashe, S. Padmanabhan, P. Padmanabhan, and E.I. Madsen. 2002. "Geochemical and Physiological Evidence for Mixed Aerobic and Anaerobic Field Biodegradation of Coal Tar Waste by Subsurface Microbial Communities." *Microbial Ecology*. Vol. 44. pp. 107-117.

Baptista, Robert J. 2007. The Chemical Industry of Shadyside (Edgewater), New Jersey: A History. <http://colorantshistory.org/ShadysideChemInd.html>. Accessed May 30, 2008.

Borough of Edgewater. 2003. Zoning Map. Revised 2003.

Bouwer, H. 1989. "The Bouwer and Rice Slug Test – An Update." *Ground Water*. vol. 27, p. 304-309

Bouwer, H., and R.C. Rice. 1976. "A Slug Test for Determining Hydraulic Conductivity of Unconfined Aquifers with Completely or Partially Penetrating Wells." *Water Resources Research*. Vol. 12, No. 3. pp. 423-428.

Bouwer, E.J., W. Zhang, L.P. Wilson, and N.D. Durant. 1997. "Biotreatment of PAH-Contaminated Soils/Sediment." *Annals of the New York Academy of Sciences*. Vol. 829, No. 1. pp. 103-117.

Brown, J.O., and J.M. Zdepski. 1994. "Coal-Combustion Cinder Fill: High Metals Concentrations From a Low Hazard, Wide-Spread Source." *Environmental Law Section Newsletter, New Jersey State Bar Association*. Vol. XI, No. 3. May. As cited in: LSP Association. 1999. Methods for Evaluating Application of the Coal Ash and Wood Ash Exemption under the Massachusetts Contingency Plan. October. <http://www.lspa.org/download/whitepapers/CoalAshWoodAshExemption.pdf>.

Brown, D.L., T.N. Narasimhan, and Z. Demir. 1995. "An Evaluation of the Bouwer and Rice Method of Slug Test Analysis." *Water Resources Research*. Vol. 31, No. 5. pp. 1239-1246.

Burr, D.H. 1832. Map of New York City and County. Scale 1: 20,000.

CH2M HILL, 2005a. Quality Assurance Project Plan (Revised), Operable Unit 1, Quanta Resources Site, Edgewater, New Jersey. October.

CH2M HILL, 2005b. Health, Safety and Environment Plan (Revised). July.

CH2M HILL, 2005c. Memorandum on Exposure Scenarios and Assumptions for the Ecological Risk Assessment. October, revised November.

CH2M HILL. 2006a. Quality Assurance Project Plan (Revised), Operable Unit 1, Quanta Resources Site, Edgewater, New Jersey. November.

CH2M HILL. 2006b. Draft Preliminary Site Characterization Report (PSCR), Operable Unit 1, Quanta Resources Site, Edgewater, N. J. February.

CH2M HILL. 2006c. Letter from CH2M HILL to Richard Ho (EPA). Re: Update on Draft Preliminary Site Characterization Report (PSCR) Comments and the Remedial Investigation Work Plan Addendum. July 17.

CH2M HILL. 2006d. Remedial Investigation/Feasibility Study Work Plan Addendum, Quanta Resources Site, Edgewater, New Jersey. July.

CH2M HILL. 2006e. Vapor Intrusion Evaluation Work Plan, Quanta Resources Site, Edgewater, New Jersey. January.

CH2M HILL. 2006f. Technical Memorandum: Evaluation of Potential Air Exposure Pathways at the Quanta Resources Site, Edgewater, New Jersey. December.

CH2M HILL. 2006g. Results from First Sampling Event, Vapor Intrusion Evaluation at 115 River Road Building, Edgewater, New Jersey. Quanta Resources Site, Edgewater, New Jersey. April.

CH2M HILL. 2006h. Vapor Intrusion Evaluation at 115 River Road Building, Edgewater, New Jersey. October.

CH2M HILL. 2006i. Letter to Richard Ho (EPA Region 2) from Scott Stoldt (CH2M HILL). Re: Modification to 3rd and 4th Quarter RI/FS Groundwater Sampling, Quanta Resources Superfund Site, Edgewater, New Jersey. April 28.

CH2M HILL. 2006j. Draft Screening-Level Ecological Risk Assessment (SLERA), Operable Unit 1, Quanta Resources Site, Edgewater, New Jersey. March.

CH2M HILL. 2006k. Draft Pathway Analysis Report for the Human Health Risk Assessment, Quanta Resources Site. April.

CH2M HILL. 2007a. Proposed Scope of Work – Supplemental Data Gap Sampling (RI Work Plan Addendum No. 2), Quanta Resources Superfund Site OU1, Edgewater, New Jersey. March.

CH2M HILL. 2007b. Draft Summary of the OU1 Supplemental Investigation Metals Soil Sampling and Evaluation of Cinder/Ash and Pyrite-Impacted Soils, Quanta Resources Superfund Site OU1, Edgewater, New Jersey. February.

CH2M HILL. 2007c. Proposed Scope of Work for the Evaluation of Cinder/Ash and Pyrite Cinder-Impacted Soils. February.

CH2M HILL. 2007d. Remedial Investigation/ Feasibility Study Work Plan Addendum No. 3 and Field Sampling Plan for the Characterization of Cinder/Ash and Reddish-Purple Soils, Quanta Resources Superfund Site OU1, Edgewater, New Jersey. April.

- CH2M HILL. 2007e. Draft OU1 Cultural Resources Study Work Plan, Quanta Resources Site, Edgewater, New Jersey. January.
- CH2M HILL. 2007f. Draft In-Situ Chemical Oxidation Treatability Study Work Plan, Operable Unit 1, Quanta Resources Site, Edgewater, New Jersey. February.
- CH2M HILL. 2007g. Vapor Intrusion Evaluation at 163 River Road Building (Jono's Restaurant). April.
- CH2M HILL. 2007h. Additional Evaluation of Potential Air Exposure Pathways at the Quanta Resources Site, Edgewater, New Jersey. March.
- CH2M HILL. 2007i. Characterization of Cinder/Ash and Reddish-Purple Soils – Field Work Summary and Analytical Results Discussion. September.
- CH2M HILL. 2007j. Draft Operable Unit 2 Preliminary Site Characterization Report. Quanta Resources Site – OU2. Edgewater, New Jersey. July.
- CH2M HILL. 2007k. Updated Vapor Intrusion Evaluation, 163 River Road (Former Jono's Restaurant), Block 93, Edgewater, NJ. October.
- CH2M HILL. 2007l. Non-Aqueous Phase Liquid (NAPL) Recovery Testing Results – Quanta Resources Superfund Site. November.
- CH2M HILL. 2007m. Quanta Resources Superfund Site – Non-Aqueous Phase Liquid (NAPL) Recovery Tests. March.
- CH2M HILL, 2008a. Final Remedial Investigation/ Feasibility Study Work Plan Addendum No. 4 for a Supplemental Remedial Investigation. July 31.
- CH2M HILL, 2008b. Draft Remedial Investigation/ Feasibility Study Work Plan Addendum No. 4 for a Supplemental Remedial Investigation. May 19.
- CH2M HILL, 2008c. Draft Vapor Intrusion Evaluation March 2008 Sample Results, 115 River Road, Edgewater, NJ. June 20.
- CH2M HILL, 2008d. Draft Vapor Intrusion Evaluation March 2008 Sample Results, 163 Old River Road (Former Jono's Restaurant), Block 93, Edgewater, NJ. July 25.
- CH2M HILL, 2008e. Vapor Intrusion Evaluation at 115 River Road Work Plan Addendum.
- Cohen, R.M., and J.W. Mercer. 1993. DNAPL Site Evaluation, C.K. Smokey. *EPA/600/R-93/022*. February.
- Cowherd, C., G.E. Muleski, P.J. Englehart, and D.A. Gillette. 1985. Rapid Assessment of Exposure to Particulate Emissions from Surface Contamination Sites. *EPA/600/8-85/002*. Office of Health and Environmental Assessment, Office of Research and Development. February.
- Dakota Technologies. 2008. TarGOST®. <http://www.dakotatechnologies.com/index.php/Service/TarGOST.html>. Accessed June 6, 2008.
- Deutsch, W.J. 1997. Groundwater Geochemistry, Fundamentals and Application to Contamination. CRC Press, LLC.

DeWolf, P., and E.L. Larison. 1921. *American Sulphuric Acid Practice*. McGraw Hill, New York, New York. <http://www.archive.org/details/americansulphuri00deworich>. Accessed November 9, 2007.

Drake, A.A., Jr., R.A. Volkert, D.H. Monteverde, G.C. Herman, H.F. Houghton, R.A. Parker, and R.F. Dalton. 1996. *Bedrock Geology of Northern New Jersey*. U.S. Geological Survey Miscellaneous Investigations Series Map I-2540-A, Scale 1:24000.

Environ. 2005. Engineering Design Report, Coal Tar Plume Control System, City Place at the Promenade—Building 700 Area, Borough of Edgewater, Bergen County, New Jersey.

Environ. 2006a. Coal Tar Delineation Report, Borough of Edgewater, Bergen County, New Jersey. March.

Environ. 2006b. Supplemental Coal Tar Delineation Report, Borough of Edgewater, Bergen County, New Jersey. July.

Environ. 2007. Additional Coal Tar Delineation Report, City Place at the Promenade—Building 700 Area, Borough of Edgewater, Bergen County, New Jersey. August.

EWMA (Environmental Waste Management Associates, LLC). 2000. *Remedial Investigation Report, Former Celotex Industrial Park, River Road, Edgewater, Bergen County, New Jersey*. Site No. NJDE981876642. September.

EWMA (Environmental Waste Management Associates, LLC). 2003. Building 700 Area and South RI—Coal Tar Investigation and V/W-15 Test Pit Excavation/Pipe Removal Investigation Report, Edgewater Enterprises, Edgewater, New Jersey. August.

EWMA (Environmental Waste Management Associates, LLC). 2004a. Coal Tar Delineation Limits—Building 700 Area and South, Edgewater Enterprises, Edgewater, New Jersey.

EWMA (Environmental Waste Management Associates, LLC). 2004b. RCRA All County Area—Soil Remediation & Groundwater Monitoring Activities Status and Results. April.

EWMA (Environmental Waste Management Associates, LLC). 2005. Remedial Investigation Report, Three Y, LLC Properties. April.

Enviro-Sciences, Inc. 1997. Celotex Remedial Investigation, Edgewater, New Jersey. June.

EPA (U.S. Environmental Protection Agency). 1988. Guidance for Conducting Remedial Investigations and Feasibility Studies Under CERCLA. *EPA/540/G-89/004*. Office of Emergency and Remedial Response, Washington, D.C.

EPA (U.S. Environmental Protection Agency). 1989. Risk Assessment Guidance for Superfund. Volume I: Human Health Evaluation Manual (Part A). Office of Emergency and Remedial Response. *USEPA/540/1-89/002*.

EPA (U.S. Environmental Protection Agency). 1991. Risk Assessment Guidance for Superfund. Volume I: Human Health Evaluation Manual (Part B: Development of Risk-based Preliminary Remediation Goals). *EPA/540/R-92/003*. December.

EPA (U.S. Environmental Protection Agency). 1992a. Estimating Potential Occurrence of DNAPL at Superfund Sites. *OSWER Publication 9355.4-07FS*. January.

- EPA (U.S. Environmental Protection Agency). 1992b. Ground Water Forum: Monitoring Well Development Guidelines for Superfund Project Managers.
- EPA (U.S. Environmental Protection Agency). 1992c. MINTEQA2 Exposure Assessment Model. <http://www.epa.gov/ceampubl/mmedia/minteq/index.htm>. Accessed September 10, 2007.
- EPA (U.S. Environmental Protection Agency). 1997a. Ecological Risk Assessment Guidance for Superfund: Process for Designing and Conducting Ecological Risk Assessments. Interim Final. *EPA/540/R-97/006*.
- EPA (U.S. Environmental Protection Agency). 1998a. Region II Groundwater Sampling Procedure, Low Stress, (Low Flow) Purging and Sampling.
- EPA (U.S. Environmental Protection Agency). 1998b. Guidelines for Ecological Risk Assessment. *EPA/630/R-95/002F*.
- EPA (U.S. Environmental Protection Agency). 1998c. Protocol for Evaluating Natural Attenuation of Chlorinated Solvents in Groundwater.
- EPA (U.S. Environmental Protection Agency). 1999. Use of Monitored Natural Attenuation at Superfund, RCRA Corrective Action, and Underground Storage Tank Sites. *OSWER Directive 9200.4-17P*. April.
- EPA. 1999b. Contract Laboratory National Functional Guidelines for Organic Data Review.
- EPA (U.S. Environmental Protection Agency). 2000. A Resource for MGP Site Characterization and Remediation: Expedited Site Characterization and Source Remediation at Former Manufactured Gas Plant Sites, Office of Solid and Emergency Response, Technology Innovation Office. *EPA-542-R-00-005*. Prepared by CH2M HILL.
- EPA (U.S. Environmental Protection Agency). 2001a. Supplemental Guidance for Developing Soil Screening Levels for Superfund Sites, Peer Review Draft, *OSWER 9355.4-24*, March.
- EPA (U.S. Environmental Protection Agency). 2001b. Risk Assessment Guidance for Superfund, Volume I: Human Health Evaluation Manual (Part D, Standardized Planning, Reporting, and Review of Superfund Risk Assessments). Final. *Publication 9285.7-47*.
- EPA (U.S. Environmental Protection Agency). 2002a. *OSWER*. Draft Guidance for Evaluating the Vapor Intrusion to Indoor Air Pathway from Groundwater and Soils (Subsurface Vapor Intrusion Guidance). *EPA/530/D-02-004*. November.
- EPA (U.S. Environmental Protection Agency). 2002b. Role of Background in the CERCLA Cleanup Program. *OSWER Directive 9285.6-07P*. April 26.
- EPA (U.S. Environmental Protection Agency). 2003. Administrative Order on Consent II-Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA)-2003-2012 for the Uplands Area, OU1.
- EPA (U.S. Environmental Protection Agency). 2004. EPA Region 9 Superfund Primary Remediation Goals (PRGs). October. <http://www.epa.gov/region09/waste/sfund/prg/>.

EPA (U.S. Environmental Protection Agency). 2005. Letter from Carole Petersen to Timothy Metcalf (Honeywell) Re: Approval of Remedial Investigation and Feasibility Study Work Plan for Operable Unit 1. May 2.

EPA (U.S. Environmental Protection Agency). 2006a. Letter from Carole Petersen to Timothy Metcalf (Honeywell) Re: Approval of the QAPP Revision. January 11.

EPA (U.S. Environmental Protection Agency, Region 2). 2006b. Letter from Richard Ho to Timothy Metcalf (Honeywell) Re: Quanta Resources Superfund Site, Edgewater, New Jersey, Administrative Orders on Consent Index Nos. II-CERCLA-2003-2012 & -2013. Comments on Preliminary Site Characterization Report. June 30.

EPA (U.S. Environmental Protection Agency). 2006c. Aerial Photographic Analysis of Quanta Resources Superfund Site Edgewater Borough, New Jersey. *TS-PIC-20602382S*. September.

EPA (U.S. Environmental Protection Agency). 2006d. Letter from Richard Ho to Timothy Metcalf (Honeywell) Re: Draft Pathways Analysis Report for the Human Health Risk Assessment, Quanta Resources Site, Operable Unit 1. July 12.

EPA (U.S. Environmental Protection Agency). 2007a. Email from Richard Ho (EPA) to Timothy Metcalf (Honeywell) and Stephen Zarlinski (CH2M HILL). EPA Comments on Scope of Work for Cinder Investigation. March 20.

EPA (U.S. Environmental Protection Agency). 2007b. Email from Richard Ho (EPA) to Stephen Zarlinski (CH2M HILL) Re: SOW for Cinder. May 4.

EPA (U.S. Environmental Protection Agency). 2007c. *Monitored Natural Attenuation of Inorganic Contaminants in Ground Water*. Vols. 1 and 2.

EPA (U.S. Environmental Protection Agency). 2007d. Foundry Sands Recycling. *EPA530-F-07-018*. April.

EPA (U.S. Environmental Protection Agency). 2008. Letter from Richard Ho to Helen Fahy (Honeywell) RE: Comments on Draft Remedial Investigation Report, Quanta Resources Superfund Site, Operable Unit One. April 7.

Ericksson, M., E. Sodersten, Z. Yu, G. Dalhammar, and W.W. Mohn. 2003. "Degradation of Polycyclic Aromatic Hydrocarbons at Low Temperature under Aerobic and Nitrate-Reducing Conditions in Enriched Cultures from Northern Soils." *Applied and Environmental Microbiology*. Vol. 69, No. 1. pp. 275-284.

Evangelou, V. P. 1995. *Pyrite Oxidation and Its Control*. CRC Press, Boca Raton, Florida.

FEMA (Federal Emergency Management Agency). 2005. Flood Insurance Rate Map. Bergen County, New Jersey. Map Number 34003C028GG. September 30.

Fetter, C.W. 1988. *Applied Hydrogeology*. 2nd ed. Merrill Publishing Company.

GeoSyntec. 1999. Engineering Evaluation/Cost Analysis (EE/CA) Report. Quanta Resources Site, Edgewater, New Jersey.



- GeoSyntec. 2000a. Engineering Evaluation/Cost Analysis (EE/CA) Report, Revision 1. Quanta Resources Site, Edgewater, New Jersey. September.
- GeoSyntec. 2000b. Removal Site Investigation Report – Revision 1, Quanta Resources Site, Edgewater, New Jersey. June.
- GeoSyntec. 2001. Engineering Evaluation/Cost Analysis (EE/CA) Report, Revision 2. Quanta Resources Site, Edgewater, New Jersey. September.
- Ghiorse, W.C., J.B. Herrick, R.L. Sandoli, and E.L. Madsen. 1995. “Natural Selection of PAH-Degrading Bacterial Guilds at Coal-Tar Sites.” *Environmental Health Perspectives*. Vol. 103, Supplement 5.
- GZA (GZA GeoEnvironmental, Inc.). 2006a. Remedial Investigation and Remedial Action Work Plan, i.Park Edgewater, LLC. January.
- GZA (GZA GeoEnvironmental, Inc.). 2006b. Pitch/Asphaltic Area Delineation/Remedial Action Work Plan Addendum, i.Park Edgewater, LLC. September.
- GZA (GZA GeoEnvironmental, Inc.). 2007a. Letter from GZA GeoEnvironmental, Inc. to Joseph Cotter, i.park Edgewater, LLC. re: Indoor Air Quality, Building 9, i.Park Edgewater, 45 River Road, Edgewater, New Jersey. March 15.
- GZA (GZA GeoEnvironmental, Inc.). 2007b. Supplemental Remedial Investigation Report and Remedial Action Workplan, i.Park Edgewater, 45 River Road, Edgewater, New Jersey. ISRA Case #E20040267. November.
- Hayes, T.D., D.G. Linz, D.V. Nakles, and A.P. Leuschner. 1996. *Management of Gas Plant Sites*. Amherst Scientific Publishers, Amherst, Massachusetts.
- Hem, J.D. 1985. *Study and Interpretation of the Chemical Characteristics of Natural Water*. 3rd ed. U.S. Geological Survey Water-Supply Paper 2254. 264 pp.
- ITRC (Interstate Technology and Regulatory Cooperation). 1998. Natural Attenuation of Chlorinated Solvents in Groundwater. Training Course Workbook. Amherst, Massachusetts. May 13 and 14.
- Jackson, R, D. Varadarajan, J. Ewing, and J. Avis. 2004. “The Migration of Viscous NAPLs in Alluvium, Implications for Brownfields Re-development and Surface Water Contamination.” INTERA Engineering, Inc., presented at the Canadian Geotechnical Conference. October.
- JMA (John Milner Associates, Inc.). 2007. Stage 1A Cultural Resources Survey Literature Search and Sensitivity Analysis, Quanta Resources Corporation Site, Edgewater, Bergen County, New Jersey.
- Johnsen, A.R., L.Y. Wick, H. and Harms. 2005. “Principles of Microbial PAH-Degradation in Soil.” *Environmental Pollution*. Vol. 133. pp. 71–84.
- Kanally, R.A., and S. Harayama. 2000. “Biodegradation of High-Molecular-Weight Polycyclic Aromatic Hydrocarbons by Bacteria.” *Journal of Bacteriology*. pp. 2059–2067.

- Kelly, W.R., T.S. Holm, S.D. Wilson, G.S. Roadcap. 2005. "Arsenic in Glacial Aquifers: Sources and Geochemical Controls." *Ground Water*. Vol. 43, No. 4. pp. 500-510. July-August.
- Kent, J.A. 1974. *Riegel's Handbook of Industrial Geochemistry*. 7th ed. Van Nostrand Reinhold Company, New York.
- Kimball, D.O., J. Ginn, and R.C. Sims. 1997. Verification of Bioremediation of PAH-Contaminated Soils Through Monitoring Biological Metabolites of Pyrene. Kansas State University HSRC 1997 Conference.
- Kose, T., A. Miyagishi, T. Mukai, K. Takimoto, and M. Okada. 2003. "Effect of Non-Aqueous Phase Liquid on Biodegradation of PAHs in Spilled Oil on Tidal Flat." *Water Science & Technology*. Vol. 47, No. 7-8. pp. 243-250.
- Langan (Langan Engineering and Environmental Services, Inc.). 2003-2004. Site Investigation Reports. Parts 1-4.
- Lundstedt, S., 2003. *Analysis of PAHs and Their Transformation Products in Contaminated Soil and Remedial Processes*. UmeaUniversity, Department of Chemistry, Sweden.
- Maxim, C.R. and Kogel-Knabner, I. 1995. "Partitioning of Polycyclic Aromatic Hydrocarbons (PAH) to Water-Soluble Soil Organic Matter." *European Journal of Soil Science*, Vol. 46, Issue 2. pp. 193-204.
- META (META Environmental, Inc.). 2004. Environmental Forensics Report. SDG PA031121. January 30.
- META (META Environmental, Inc.). 2006a. Environmental Forensics Report. SDG CH051203. January 6.
- META (META Environmental, Inc.). 2006b. Environmental Forensics Report. SDG CH060526. June 20.
- NJDEP (New Jersey Department of Environmental Protection). 1989. Division of Hazardous Waste Management Bureau of Planning and Assessment. RCRA Facility Assessment for RCRA Corrective Action Program, Lever Brothers, 45 River Road, Edgewater, Bergen County, New Jersey. December 8.
- NJDEP (New Jersey Department of Environmental Protection). 1992, revised 2005. Field Sampling Procedures Manual.
- NJDEP (New Jersey Department of Environmental Protection). 1999. Site Remediation Program Soil Cleanup Criteria. May. <http://www.state.nj.us/dep/srp/regs/scc/> Accessed March 13, 2007.
- NJDEP (New Jersey Department of Environmental Protection). 2004. Historic Fill map.
- NJDEP (New Jersey Department of Environmental Protection). 2005. Vapor Intrusion Guidance. October.
- NJDEP (New Jersey Department of Environmental Protection). 2007. Vapor Intrusion Guidance. March.

- NJDOHSS (New Jersey Department of Health and Senior Services). 2002. Public Health Assessment, Quanta Resources Corporation, Edgewater, Bergen County, New Jersey. September 25.
- NSF (National Science Foundation). 1977. Lead in the Environment. NSF/RA-770214. Washington. DC.
- OBG (O'Brien & Gere Engineers, Inc.). 2004. Preliminary Assessment, Heagney/Frola Properties, Old River Road, Edgewater, New Jersey. August.
- Owabor, C.N., and O.F. Ogunbor, 2007. "Naphthalene and Pyrene Degradation in Contaminated Soil as a Function of the Variation of Particle Size and Percent Organic Matter." *African Journal of Biotechnology*. Vol. 6, Issue 4. pp. 436–440.
- Parsons. 1997. Pre-Design Investigation at the Quanta Resources Site, Edgewater, New Jersey. Prepared for AlliedSignal, Inc. May.
- Parsons. 1998. Data Report for Pre-Design Investigation at the Quanta Resources Site, Edgewater, New Jersey. Prepared for AlliedSignal, Inc. March.
- Parsons. 1999. Summary Report, Quanta Resources Site, Edgewater, New Jersey. Prepared for AlliedSignal. May.
- Parsons. 2005. Remedial Investigation/Feasibility Study Work Plan, Operable Unit 1, Quanta Resources Site, Edgewater, New Jersey. May.
- PMK Group. 2000. Report: Subsurface Investigation, River Road, Edgewater, New Jersey. September 29.
- PS&S (Paulus, Sokolwski, and Sator, LLC). 2002. Supplemental Data Submission in Support of Containment Interim Removal Action, Quanta Resources Site. Prepared for U.S. Environmental Protection Agency on behalf of 115 River Road, LLC. September.
- Ramboll, M.B., S. Knudsen, J.N. Andersen. 2001. Natural Degradation of PAHs in Soil and Groundwater. Danish EPA, Environmental Project No. 582.
- Raviv (Dan Raviv Associates, Inc.). 2002. Final Soil Remedial Investigation Report, Arsenic Area, Former Celotex Industrial Park, Edgewater, New Jersey. July.
- Raviv (Dan Raviv Associates, Inc.). 2004. Groundwater Remedial Investigation Report, Arsenic Area, Former Celotex Industrial Park, Edgewater, New Jersey.
- Raviv (Dan Raviv Associates, Inc.). 2005. Supplemental Groundwater Investigation Report, Arsenic Area, Former Celotex Industrial Park, Edgewater, New Jersey. May 9.
- Reed B.E., R.E. Moore, S.R. Cline. 1995. "Soil Flushing of a Sandy Loam Contaminated with Pb(II), PbSO<sub>4</sub> (s), PbCO<sub>3</sub> (3) or Pb-naphthalene: Column Results." *Journal of Soil Contamination*. Vol. 4, No. 3. pp. 243–267.
- Rivett, M.O. 1995. "Soil-Gas Signatures from Volatile Chlorinated Solvents: Borden Field Experiments." *Ground Water*. Vol. 33, No. 1. January–February.

- Sanders, P.F. 2003. Ambient Levels of Metals in New Jersey Soils. Research Project Summary. New Jersey Department of Environmental Protection, Division of Science, Research and Technology. Trenton.
- Sanborn® Insurance Maps. Various years as noted. Provided by Environmental Data Resources, Inc.
- Smedley, P.L., D.G. Kinniburgh. 2002. "A Review of the Source, Behaviour and Distribution of Arsenic in Natural Waters." *Applied Geochemistry*. Vol. 17. pp. 517-568. May.
- Spectrum Laboratories, Inc., 2007. Chemical fact sheets, various compounds. <http://www.speclab.com/compound/chemabc.htm>.
- Stanford, S.D., 1993. Surficial Geologic Map of the Hackensack Quadrangle, Bergen and Passaic Counties, New Jersey. 1993.
- St. Germain, R. 2006. Dakota Technologies, personal communication. October.
- Swayze, G.A., R.N. Clark, R.M. Pearson, and K.E. Livo. 1996. *Mapping Acid-Generating Minerals at the California Gulch Superfund Site in Leadville, Colorado using Imaging Spectroscopy*. Summaries of the United States Geological Survey (USGS) 6th Annual JPL Airborne Earth Science Workshop March 4-8, 1996. <http://speclab.cr.usgs.gov/PAPERS/Leadville95/leadville1.html>
- TOXNET, 2007. Toxicology Data Network. <http://toxnet.nlm.nih.gov>. Accessed November 14, 2007.
- United Kingdom Environment Agency. 2003. *An Illustrated Handbook of DNAPL Transport and Fate in the Subsurface*. R&D Publication 133. Prepared by B.H. Kueper and G.P. Weatherall. June.
- U.S. Census. 2000. Town of Edgewater, N.J. <http://www.census.gov/main/www/cen2000.html>.
- U.S. Census. 2005. Town of Edgewater, N.J. <http://www.census.gov/popest/cities/SUB-EST2005-5.html>.
- University of Wisconsin Green Bay Solid and Hazardous Waste Education Center. 2007. <http://www3.uwm.edu/Dept/shwec/links/uwgb/foundry.htm>. June 20.
- Walker, A.H., 1876. A.H. Walker Atlas of Bergen County Map of Shadyside, New Jersey.
- Welch, A.H., D.B. Westjohn, D.R. Helsel, and R.B. Wanty. 2000. "Arsenic in Ground Water of the United States-Occurrence and Geochemistry." *Ground Water*. Vol. 38, No.4. pp. 589-604.
- Weston (Weston Solutions, Inc.). 1985. *Draft Site Mitigation Work Plan, Frola/Van Dohln Tank Farm (Quanta Resources, Inc.), Edgewater, New Jersey*. Prepared for John Witkowski, Response and Prevention Branch, Emergency and Remedial Response Division, US EPA, Region II. February 15, 1985.
- Weston (Weston Solutions, Inc.). 1992, 1995-1998. Miscellaneous site investigation memorandums, sample location drawings and analytical results.

Wilson, M.S., C. Bakermans, and E.L. Madsen. 1999. "In-Situ, Real Time Catabolic Gene Expression: Extraction and Characterization of Naphthalene Dioxygenase MRNA Transcripts from Groundwater." *Applied and Environmental Microbiology*. p. 80-87.

#### **Miscellaneous Maps and Photographs Used:**

Environmental Data Resources, Inc. 2004. The EDR Aerial Photo Decade Package, Honeywell Edgewater Property, 163 River Road. Edgewater, NJ 07020. *Inquiry No. 1184509.5*. May 4.

Library of Congress. Spencer Kellogg & Sons, Incorporated, Pier & Transit Shed, 139-155 River Road, Edgewater, Bergen County, NJ. Photocopy of photograph, c. 1945. Aerial view to north. From the Thomas Flagg Collection. *Call no. HAER NJ,2-EDWA,2-6*. Prints and Photograph Division, Washington, D.C. <http://hdl.loc.gov/loc.pnp/hhh.nj0988>.

Library of Congress. Spencer Kellogg & Sons, Incorporated, Pier & Transit Shed, 139-155 River Road, Edgewater, Bergen County, NJ. Photocopy of photograph, c. 1948. Aerial view to southwest. Courtesy of Fairchild Aerial Surveys, Inc.. *Call no. HAER NJ,2-EDWA,2-7*. Prints and Photograph Division, Washington, D.C. <http://hdl.loc.gov/loc.pnp/hhh.nj0988>.

Rumsey Collection. 2005. Watson's New Map of New-York and Adjacent Cities. Published By Gaylord Watson, 16 Beekman St. 1874. Entered 1869, by Gaylord Watson New York. (inset) Map showing the Hudson River and Adjoining Country. Image No. 1178001. <http://www.davidrumsey.com>.

**TABLE 2-1**

Summary of Soil Boring Information  
*Quanta Resources Superfund Site, OU1*  
*Edgewater, New Jersey*

Boring ID	Installation Date	Northing	Easting	Ground Elevation (ft. msl)	Property	Total Depth (ft. bgs)	Logged Interval (ft. bgs)	Method
SB-1	12/11/2005	718395.13	633391.71	7.4	115 River Road	20	0-20	Direct-push Geoprobe
SB-2	8/18/2005	718488.76	633460.53	7.2	Quanta	30	0-2 Logged 2-8 No Log* 8-30 Logged	4-1/4" HSA, 2" SS** 8" rolling air rotary bit 4-1/4" HSA, 2" SS
SB-3	8/22/2005	718578.89	633480.43	6.0	Quanta	22	0 -1 No Log*** 1-22 Logged	4-1/4" HSA 4-1/4" HSA, 2" SS
SB-4	12/10/2005	718553.53	633145.04	6.8	115 River Road	30	0-30	Direct-push Geoprobe
SB-5	7/28/2005	718689.60	633256.88	6.3	Quanta	24	0-3 No Log*** 3-24 Logged	4-1/4" HSA 4-1/4" HSA, 2" SS
SB-6	8/2/2005	718727.69	633119.09	6.1	Quanta	24	0-24	4-1/4" HSA, 2" SS
SB-7	8/17/2005	718822.50	633174.56	6.6	Quanta	24	0-10 No Log* 10-24 Logged	8" rolling air rotary bit 4-1/4" HSA, 2" SS
SB-8	10/9/2005	718716.50	632894.53	6.8	115 River Road	27	0-1 No Log*** 1-2 Logged 2-3 No Log*** 3-27 Logged	4-1/4" HSA 4-1/4" HSA, 2" SS 4-1/4" HSA 4-1/4" HSA, 2" SS
SB-9	8/18/2005	718891.74	632988.39	6.3	Quanta	28	0-10 No Log*** 10-28 Logged	8" rolling air rotary bit 4-1/4" HSA, 2" SS
SB-10	8/23/2005	718931.19	632714.57	5.4	Block 93 North	26	0-26	4-1/4" HSA, 2" SS
SB-11	8/23/2005	718994.03	632748.25	7.2	Block 93 North	24	0-24	4-1/4" HSA, 2" SS
SB-12	10/25/2005	719231.90	632945.15	11.5	River Road ROW	30	0-30	Direct-push Geoprobe
SB-13	8/3/2005	718979.58	632676.38	5.6	Block 93 North	12	0-12	4-1/4" HSA, 2" SS
SB-14	10/24/2005	719288.13	632753.49	12.5	Gorge Road ROW	25	0-25	Direct-push Geoprobe
SB-15	10/25/2005	719360.51	633025.42	12.2	River Road ROW	30	0-5 No Log^ 5-30 Logged	Air-knifed Direct-push Geoprobe
SB-16	11/15/2005	718298.40	633068.54	7.4	Former Lever Brothers	27	0-13 No Log* 13-27 Logged	10" rolling air rotary bit 4-1/4" HSA, 2" SS
SB-17	12/10/2005	718520.83	632876.49	6.6	115 River Road	30	0-30 Logged	Direct-push Geoprobe
SB-18	11/18/2005	718424.75	632876.34	7.5	Former Lever Brothers	27	0-13 No Log* 13-27 Logged	10" rolling air rotary bit 4-1/4" HSA, 2" SS

**TABLE 2-1**

Summary of Soil Boring Information  
*Quanta Resources Superfund Site, OU1*  
*Edgewater, New Jersey*

Boring ID	Installation Date	Northing	Easting	Ground Elevation (ft. msl)	Property	Total Depth (ft. bgs)	Logged Interval (ft. bgs)	Method
SB-19	10/12/2006	718968.76	632729.16	6.5	Block 93 North	20	0-20 Logged	Direct-push Geoprobe
SB-20	10/12/2006	719048.59	632777.92	9.0	Block 93 North	30	0-30 Logged	Direct-push Geoprobe
SB-21	10/13/2006	718991.28	632767.01	11.3	Block 93 North	25	0-25 Logged	Direct-push Geoprobe
SB-22	10/13/2006	718904.11	632739.08	10.2	Block 93 North	25	0-25 Logged	Direct-push Geoprobe
SB-23	10/18/2006	718952.75	632653.42	5.5	Block 93 North	20	0-20 Logged	Direct-push Geoprobe
SB-24	10/16/2006	719038.47	632710.96	6.5	Block 93 North	25	0-25 Logged	Direct-push Geoprobe
SB-25	10/17/2006	718914.28	632622.23	5.5	Block 93 Central	35	0-35 Logged	Direct-push Geoprobe
SB-26	10/13/2006	719040.43	632540.53	5.8	Block 93 North	25	0-25 Logged	Direct-push Geoprobe
SB-27	10/13/2006	719075.44	632620.75	7.7	Block 93 North	30	0-30 Logged	Direct-push Geoprobe
TL14-09	10/11/2006	718826.70	632871.19	7.3	Quanta	25	0-25 Logged	Direct-push Geoprobe
TL15-09	10/10/2006	718912.59	632918.86	9.7	Quanta	25	0-25 Logged	Direct-push Geoprobe
TL16-06	10/11/2006	718849.04	633212.62	6.7	Quanta	30.5	0-30.5 Logged	Direct-push Geoprobe
TL16-07	10/11/2006	718901.56	633127.32	6.8	Quanta	30	0-30 Logged	Direct-push Geoprobe
TL16-09	10/11/2006	719003.26	632974.53	11.8	Quanta	25	0-25 Logged	Direct-push Geoprobe
TL17-06	10/12/2006	718923.63	633252.64	6.8	Quanta	25	0-25 Logged	Direct-push Geoprobe
TL17-07	10/12/2006	718972.23	633152.43	6.9	Quanta	20	0-20 Logged	Direct-push Geoprobe
TL17-08	10/12/2006	719016.20	633069.96	7.2	Quanta	25	0-25 Logged	Direct-push Geoprobe
TL10-03.5	10/10/2006	718206.73	633113.24	7.4	Former Lever Brothers	30	0-30 Logged	Direct-push Geoprobe
TL11-07.5	10/10/2006	718498.18	632824.93	8.6	Former Lever Brothers	25	0-25 Logged	Direct-push Geoprobe
TL17-05	10/9/2006	718882.28	633349.90	15.2	Former Celotex	30	0-30 Logged	Direct-push Geoprobe
TL18.5-0.5	10/18/2006	718775.77	633812.18	12.1	Former Celotex	30	0-15 No Log* 15-30 Logged	Air Rotary Drilled Direct-push Geoprobe
TL18.5-1.5	10/9/2006	718827.12	633728.06	13.7	Former Celotex	19.5	0-19.5	Direct-push Geoprobe
TL19-0.5	10/18/2006	718818.55	633838.44	11.7	Former Celotex	30	0-15 No Log* 15-30 Logged	Air Rotary Drilled Direct-push Geoprobe
TL12-10.75	10/17/2006	718730.34	632588.83	6.7	Block 93 South	30	0-30 Logged	Direct-push Geoprobe
TL12-11.75	10/17/2006	718807.55	632513.46	5.9	Block 93 Central	25	0-25 Logged	Direct-push Geoprobe
TL12.5-11.75	10/17/2006	718854.35	632550.74	5.5	Block 93 Central	23	0-23 Logged	Direct-push Geoprobe
TL12.5-12.25	10/18/2006	718874.41	632490.83	5.6	Block 93 Central	30	0-30 Logged	Direct-push Geoprobe
TL14-10.75	10/13/2006	718926.06	632703.09	5.2	Block 93 North	25	0-25 Logged	Direct-push Geoprobe
TL14.5-11.25	10/16/2006	719005.93	632681.63	6.4	Block 93 North	30	0-30 Logged	Direct-push Geoprobe
TL15-10.75	10/16/2006	719011.40	632755.34	7.7	Block 93 North	50	0-50 Logged	Direct-push Geoprobe

**TABLE 2-1**

Summary of Soil Boring Information  
*Quanta Resources Superfund Site, OU1*  
*Edgewater, New Jersey*

Boring ID	Installation Date	Northing	Easting	Ground Elevation (ft. msl)	Property	Total Depth (ft. bgs)	Logged Interval (ft. bgs)	Method
SB-28 <sup>1</sup>	6/5/2007	719191.85	632578.96	8.8	Block 93 North	10	0-10 Logged	Direct-push Geoprobe
SB-29 <sup>1</sup>	6/5/2007	719045.10	632565.07	6.3	Block 93 North	15	0-15 Logged	Direct-push Geoprobe
SB-30 <sup>1</sup>	6/5/2007	719117.98	632612.12	7.8	Block 93 North	20	0-20 Logged	Direct-push Geoprobe
SB-31 <sup>1</sup>	6/5/2007	718950.91	632638.30	5.4	Block 93 North	15	0-15 Logged	Direct-push Geoprobe
SB-34 <sup>1</sup>	6/4/2007	718375.54	632984.09	7.4	Former Lever Brothers	15	0-15 Logged	Direct-push Geoprobe
SB-35 <sup>1</sup>	6/4/2007	718049.01	633342.97	4.8	Former Lever Brothers	15	0-15 Logged	Direct-push Geoprobe
SB-36 <sup>1</sup>	6/6/2007	718989.83	633199.49	6.8	Quanta	15	0-15 Logged	Direct-push Geoprobe
SB-37 <sup>1</sup>	6/6/2007	719007.72	633131.07	6.9	Quanta	10	0-10 Logged	Direct-push Geoprobe
SB-38 <sup>1</sup>	6/6/2007	719022.99	633018.06	6.5	Quanta	10	0-10 Logged	Direct-push Geoprobe

Notes:

<sup>1</sup> Boring drilled as part of the Cinder/Ash Investigation (RI/FS Work Plan Addendum No. 3)

Soil boring summary table does not include soil borings drilled as part of monitoring well installation. Monitoring wells are summarized in Table 2-3.

\* - Air-drilled, no log

\*\* - 4-1/4" ID hollow stem auger with 2" ID split spoon

\*\*\* - Hollow stem augered through obstruction

^ - Air-knifed due to possible buried utilities

ID - Inner diameter

ft. bgs - Feet below ground surface

ft. msl - Feet referenced to mean sea level, NAVD 88

ROW - Right of way

SS - Split spoon



Soil Sample Analytical Method Summary  
Quanta Resources Superfund Site, OU1  
Edgewater, New Jersey

306154  
Page 1 of 27

TABLE 2-2

Soil Sample Analytical Method Summary  
 Quanta Resources Superfund Site, OU1  
 Edgewater, New Jersey

				Parameter																										
Location	Start Depth (ft bgs)	End Depth (ft bgs)	Sampling Date	Ammonia	Atterberg Limits	Chromium (VI)	Cyanide	Grain Size	Leaching Procedure	Leaching Procedure - Metals Only	Metals	Mercury	Oil & Grease	PCBs	Percent Moisture	Pesticides	Petrographic	pH	Phenolics	Porosity	Redox Potential	SVOCs	Total Organic Carbon	Fraction Organic Carbon	Total Solids	TPH	VOCs	X-Ray Diffraction	Unknown*	
3Y-B5	4	4.5	3/8/2005	X			X				X	X		X		X							X					X		
	6	6.5	3/8/2005	X			X				X	X		X		X							X					X		
	16	16.5	3/8/2005	X			X				X	X		X		X							X					X		
	17	17.5	3/8/2005	X			X				X	X		X		X							X					X		
	38	38.5	3/8/2005	X			X				X	X		X		X							X					X		
AD-SS-01	0	0.5	12/21/2006								X							X					X							
AD-SS-02	0	0.5	12/21/2006								X							X					X							
AD-SS-03	0	0.5	12/21/2006								X							X					X							
AD-SS-04	0	0.5	12/21/2006								X							X					X							
AD-SS-05	0	0.5	12/21/2006								X							X					X							
AD-SS-06	0	0.5	12/21/2006								X							X					X							
AD-SS-07	0	0.5	12/21/2006								X							X					X							
AD-SS-08	0	0.5	12/21/2006								X							X					X							
AD-SS-09	0	0.5	12/21/2006								X							X					X							
AD-SS-10	0	0.5	12/21/2006								X							X					X							
AD-SS-11	0	0.5	12/21/2006								X							X					X							
AD-SS-12	0	0.5	12/21/2006								X							X					X							
B-1-90	1	3	5/21/1990																											X
	4	6	5/21/1990																											X
B-10	0	1	6/14/2000																											X
	3	4	6/14/2000																											X
B-11	0	1	6/14/2000																											X
	3	4	6/14/2000																											X
B-12	0	1	6/14/2000																											X
	3	4	6/14/2000																											X
B-13	0	1	6/15/2000																											X
B-14	0	1	6/15/2000																											X
	3	4	6/15/2000																											X
B-15	0	1	6/15/2000																											X
	3	4	6/15/2000																											X
B-16	0	1	6/15/2000																											X
	3	4	6/15/2000																											X
B-17	0	1	6/15/2000																											X
	3	4	6/15/2000																											X
B-18	0	1	6/15/2000																											X
B-19_1	6	6.5	11/21/2005																									X		
B-19	0	1	6/15/2000																											X

TABLE 2-2

Soil Sample Analytical Method Summary  
 Quanta Resources Superfund Site, OU1  
 Edgewater, New Jersey

				Parameter																										
Location	Start Depth (ft bgs)	End Depth (ft bgs)	Sampling Date	Ammonia	Atterberg Limits	Chromium (VI)	Cyanide	Grain Size	Leaching Procedure	Leaching Procedure - Metals Only	Metals	Mercury	Oil & Grease	PCBs	Percent Moisture	Pesticides	Petrographic	pH	Phenolics	Porosity	Redox Potential	SVOCs	Total Organic Carbon	Fraction Organic Carbon	Total Solids	TPH	VOCs	X-Ray Diffraction	Unknown*	
B-1A	1	1.5	2/28/1997																											X
	4.5	5	2/28/1997																											X
B-1B	1	1.5	2/28/1997																											X
	5.5	6	2/28/1997																											X
B-1C	1	1.5	2/28/1997																											X
	6.5	7	2/28/1997																											X
B-2-90	1	3	5/21/1990																											X
B-20	5.5	6	11/21/2005																											
B-21	6	6.5	11/21/2005																									X		
B-22	5	5.5	11/21/2005																									X		
B-23	6	6.5	11/21/2005																									X		
B-24	6.5	7	11/21/2005																									X		
B-25	2	2.5	11/21/2005																									X		
B-27	6	6.5	11/21/2005																									X		
B-2A	8.5	9	2/27/1997																											X
	12.5	13	2/27/1997																											X
B-2B	9	9.5	2/27/1997																											X
	13.5	14	2/27/1997																											X
B-2C	9	9.5	2/26/1997																											X
	13.5	14	2/26/1997																											X
B-2D	12.5	13	2/26/1997																											X
	16.5	17	2/26/1997																											X
B-2	3	4	11/9/1998								X												X			X				X
B-3-90	1	3	5/21/1990																											X
B-3A	5.5	6	3/19/1997																											X
	14.5	15	3/19/1997																											X
B-3B	9.5	10	4/3/1997																											X
	13.5	14	4/3/1997																											X
B-3D	11.5	12	4/3/1997																											X
	13	13.5	4/3/1997																											X
B-3E	11	11.5	4/3/1997																											X
	13	13.5	4/3/1997																											X
B-3	13	14	11/11/1998								X												X			X				
	14	15	11/11/1998								X												X			X				
B-4-90	1	3	5/21/1990																											X
B-4A	10.5	11	2/21/1997																											X
	15.5	16	2/21/1997																											X

TABLE 2-2

Soil Sample Analytical Method Summary  
 Quanta Resources Superfund Site, OU1  
 Edgewater, New Jersey

				Parameter																										
Location	Start Depth (ft bgs)	End Depth (ft bgs)	Sampling Date	Ammonia	Atterberg Limits	Chromium (VI)	Cyanide	Grain Size	Leaching Procedure	Leaching Procedure - Metals Only	Metals	Mercury	Oil & Grease	PCBs	Percent Moisture	Pesticides	Petrographic	pH	Phenolics	Porosity	Redox Potential	SVOCs	Total Organic Carbon	Fraction Organic Carbon	Total Solids	TPH	VOCs	X-Ray Diffraction	Unknown*	
B-4B	10.5	11	2/21/1997																											X
	15.5	16	2/21/1997																											X
B-4C	10.5	11	2/21/1997																											X
	14.5	15	2/21/1997																											X
B-4	31	32	11/16/1998								X											X				X				
B-5-90	1	3	5/21/1990																				X				X			X
	4	6	5/21/1990																											X
B-6-90	1	3	5/22/1990																											X
	4	5	5/22/1990																											X
B-7-90	1	3	5/22/1990																											X
B-8-90	1	3	5/22/1990																											X
C-10	5.5	6	4/9/1997																											X
	7.5	8	4/9/1997																											X
C-11	6.5	7	4/9/1997																											X
	8.5	9	4/9/1997																											X
C-12	10	10.5	4/9/1997																											X
	6.5	7	4/9/1997																											X
C-13	6.5	7	4/9/1997																											X
	7.5	8	4/9/1997																											X
C-14	4.5	5	4/16/1997																											X
C-15	1.5	2	4/19/1997																											X
	6.5	7	4/19/1997																											X
C-16	6	6.5	4/19/1997																											X
C-17	5.5	6	4/19/1997																											X
	8.5	9	4/19/1997																											X
C-18	5	5.5	4/19/1997																											X
	10.5	11	4/19/1997																											X
C-19	5	5.5	4/19/1997																											X
	7.5	8	4/19/1997																											X
C-20	6.5	7	4/9/1997																											X
	8.5	9	4/9/1997																											X
C-21	0	0.5	4/10/1997																											X
	6	6.5	4/10/1997																											X
C-22	5.5	6	4/10/1997																											X
	7.5	8	4/10/1997																											X
C-23	7	7.5	4/10/1997																											X
	9.5	10	4/10/1997																											X

TABLE 2-2

Soil Sample Analytical Method Summary

Quanta Resources Superfund Site, OU1

Edgewater, New Jersey

Location	Start Depth (ft bgs)	End Depth (ft bgs)	Sampling Date	Parameter																									
				Ammonia	Atterberg Limits	Chromium (VI)	Cyanide	Grain Size	Leaching Procedure	Leaching Procedure - Metals Only	Metals	Mercury	Oil & Grease	PCBs	Percent Moisture	Pesticides	Petrographic	pH	Phenolics	Porosity	Redox Potential	SVOCs	Total Organic Carbon	Fraction Organic Carbon	Total Solids	TPH	VOCs	X-Ray Diffraction	Unknown*
C-24	6.5	7	4/11/1997																										X
	8.5	9	4/11/1997																										X
C-25	7	7.5	4/11/1997																										X
	9	9.5	4/11/1997																										X
C-26	7	7.5	4/11/1997																										X
	9	9.5	4/11/1997																										X
C-27	0	0.5	4/11/1997																										X
	5.5	6	4/11/1997																										X
	7.5	8	4/11/1997																										X
C-28	5	5.5	4/10/1997																										X
C-29A	5	5.5	4/17/1997																										X
	7	7.5	4/17/1997																										X
C-29	3	3.5	4/10/1997																										X
	6.5	7	4/10/1997																										X
C-30A	0	0.5	4/17/1997																										X
	5.5	6	4/17/1997																										X
	8.5	9	4/17/1997																										X
C-30	4.5	5	4/10/1997																										X
	6.5	7	4/10/1997																										X
C-31	4.5	5	4/10/1997																										X
	6.5	7	4/10/1997																										X
C-32	5	5.5	4/8/1997																										X
	7	7.5	4/8/1997																										X
C-33	8	8.5	4/8/1997																										X
C-34	5.5	6	4/8/1997																										X
	7.5	8	4/8/1997																										X
C-35	6	6.5	4/8/1997																										X
	7.5	8	4/8/1997																										X
C-36	0	0.5	4/19/1997																										X
	8.5	9	4/19/1997																										X
C-40	6.5	7	4/8/1997																										X
	8.5	9	4/8/1997																										X
	9.5	10	4/8/1997																										X
C-41	unk	unk	4/8/1997																										X
	6	6.5	4/8/1997																										X
C-42	9.5	10	4/8/1997																										X

TABLE 2-2

Soil Sample Analytical Method Summary  
 Quanta Resources Superfund Site, OU1  
 Edgewater, New Jersey

				Parameter																										
Location	Start Depth (ft bgs)	End Depth (ft bgs)	Sampling Date	Ammonia	Atterberg Limits	Chromium (VI)	Cyanide	Grain Size	Leaching Procedure	Leaching Procedure - Metals Only	Metals	Mercury	Oil & Grease	PCBs	Percent Moisture	Pesticides	Petrographic	pH	Phenolics	Porosity	Redox Potential	SVOCs	Total Organic Carbon	Fraction Organic Carbon	Total Solids	TPH	VOCs	X-Ray Diffraction	Unknown*	
C-43	6.5	7	4/8/1997																											X
	9.5	10	4/8/1997																											X
C-44	5.5	6	4/14/1997																											X
	8.5	9	4/14/1997																											X
C-45	0	0.5	4/14/1997																											X
	5.5	6	4/14/1997																											X
	8.5	9	4/14/1997																											X
C-46	6.5	7	4/14/1997																											X
C-47	5.5	6	4/14/1997																											X
	8.5	9	4/14/1997																											X
C-48	7	7.5	4/4/1997																											X
	8	8.5	4/4/1997																											X
C-50	6.5	7	4/7/1997																											X
	8.5	9	4/7/1997																											X
C-51	6	6.5	4/7/1997																											X
	8.5	9	4/7/1997																											X
C-52	5.5	6	4/7/1997																											X
	8.5	9	4/7/1997																											X
C-56	6	6.5	4/16/1997																											X
	12	12.5	4/16/1997																											X
C-57	0	0.5	4/16/1997																											X
	7	7.5	4/16/1997																											X
	11.5	12	4/16/1997																											X
C-58	0	0.5	4/22/1997																											X
	5.5	6	4/17/1997																											X
	9.5	10	4/14/1997																											X
C-59	5.5	6	4/17/1997																											X
	9	9.5	4/17/1997																											X
C-60	6	6.5	4/17/1997																											X
C-61	0	0.5	4/22/1997																											X
	4.5	5	4/17/1997																											X
	7.5	8	4/17/1997																											X
C-62	2	2.5	4/15/1997																											X
	5.5	6	4/15/1997																											X
C-63	3	3.5	4/15/1997																											X
	6	6.5	4/15/1997																											X

TABLE 2-2

Soil Sample Analytical Method Summary  
 Quanta Resources Superfund Site, OU1  
 Edgewater, New Jersey

				Parameter																										
Location	Start Depth (ft bgs)	End Depth (ft bgs)	Sampling Date	Ammonia	Atterberg Limits	Chromium (VI)	Cyanide	Grain Size	Leaching Procedure	Leaching Procedure - Metals Only	Metals	Mercury	Oil & Grease	PCBs	Percent Moisture	Pesticides	Petrographic	pH	Phenolics	Porosity	Redox Potential	SVOCs	Total Organic Carbon	Fraction Organic Carbon	Total Solids	TPH	VOCs	X-Ray Diffraction	Unknown*	
C-64	4	4.5	4/15/1997																											X
	6	6.5	4/15/1997																											X
C-65	2	2.5	4/15/1997																											X
	3.5	4	4/14/1997																											X
C-66	3.5	4	4/14/1997																											X
	13	13.5	4/14/1997																											X
C-67	0	0.5	4/14/1997																											X
	4	4.5	4/14/1997																											X
	12	12.5	4/14/1997																											X
C-69	3.5	4	4/15/1997																											X
	5	5.5	4/15/1997																											X
C-6	8.5	9	4/9/1997																											X
C-70A	6	6.5	4/15/1997																											X
C-70	1	1.5	4/15/1997																											X
C-71	0.5	1	4/15/1997																											X
	5	5.5	4/15/1997																											X
C-74	0	0.5	4/19/1997																											X
	5	5.5	4/19/1997																											X
C-75	0	0.5	4/19/1997																											X
	3.5	4	4/19/1997																											X
	13.5	14	4/19/1997																											X
C-76	0	0.5	4/20/1997																											X
	3.5	4	4/20/1997																											X
	9	9.5	4/20/1997																											X
C-77	0	0.5	4/20/1997																											X
	3.5	4	4/20/1997																											X
	12.5	13	4/20/1997																											X
	15.5	16	4/20/1997																											X
C-78	0	0.5	4/20/1997																											X
	3.5	4	4/20/1997																											X
	11.5	12	4/20/1997																											X
C-79	0	0.5	4/20/1997																											X
	4.5	5	4/20/1997																											X
	6.5	7	4/20/1997																											X
C-7	5.5	6	4/9/1997																											X
	8.5	9	4/9/1997																											X
C-80	0	0.5	4/20/1997																											X

TABLE 2-2

Soil Sample Analytical Method Summary  
 Quanta Resources Superfund Site, OU1  
 Edgewater, New Jersey

Location	Start Depth (ft bgs)	End Depth (ft bgs)	Sampling Date	Parameter																									
				Ammonia	Atterberg Limits	Chromium (VI)	Cyanide	Grain Size	Leaching Procedure	Leaching Procedure - Metals Only	Metals	Mercury	Oil & Grease	PCBs	Percent Moisture	Pesticides	Petrographic	pH	Phenolics	Porosity	Redox Potential	SVOCs	Total Organic Carbon	Fraction Organic Carbon	Total Solids	TPH	VOCs	X-Ray Diffraction	Unknown*
C-80	4.5	5	4/20/1997																										X
C-81	0	0.5	4/20/1997																										X
	3.5	4	4/20/1997																										X
	8.5	9	4/20/1997																										X
																													X
C-82	0	0.5	4/20/1997																										X
	3	3.5	4/20/1997																										X
	14.5	15	4/20/1997																										X
C-83	0	0.5	4/20/1997																										X
	3	3.5	4/20/1997																										X
	5	5.5	4/20/1997																										X
C-84A	6	6.5	4/20/1997																										X
C-84	0	0.5	4/20/1997																										X
	3	3.5	4/20/1997																										X
C-85	0	0.5	4/21/1997																										X
	4	4.5	4/21/1997																										X
	12	12.5	4/21/1997																										X
C-86	0	0.5	4/21/1997																										X
	4	4.5	4/21/1997																										X
	13	13.5	4/21/1997																										X
C-87	0	0.5	4/22/1997																										X
	2.5	3	4/22/1997																										X
	11.5	12	4/22/1997																										X
C-88	0	0.5	4/22/1997																										X
	4.5	5	4/22/1997																										X
	11.5	12	4/22/1997																										X
C-89	0	0.5	4/22/1997																										X
	4	4.5	4/22/1997																										X
	13.5	14	4/22/1997																										X
C-8	4.5	5	4/17/1997																										X
	10.5	11	4/17/1997																										X
C-90	0	0.5	4/23/1997																										X
	6	6.5	4/23/1997																										X
	13	13.5	4/23/1997																										X
C-91	0	0.5	4/23/1997																										X
	3	4	4/23/1997																										X
	13.5	14	4/23/1997																										X



TABLE 2-2

Soil Sample Analytical Method Summary

Quanta Resources Superfund Site, OU1

Edgewater, New Jersey

Location	Start Depth (ft bgs)	End Depth (ft bgs)	Sampling Date	Parameter																									
				Ammonia	Atterberg Limits	Chromium (VI)	Cyanide	Grain Size	Leaching Procedure	Leaching Procedure - Metals Only	Metals	Mercury	Oil & Grease	PCBs	Percent Moisture	Pesticides	Petrographic	pH	Phenolics	Porosity	Redox Potential	SVOCs	Total Organic Carbon	Fraction Organic Carbon	Total Solids	TPH	VOCs	X-Ray Diffraction	Unknown*
C-92	0	0.5	4/23/1997																										X
	3.5	4	4/23/1997																										X
	10.5	11	4/23/1997																										X
C-93	0	0.5	4/23/1997																										X
	3.5	4	4/23/1997																										X
	16	16.5	4/23/1997																										X
C-94	0	0.5	4/23/1997																										X
	3.5	4	4/23/1997																										X
	15	15.5	4/23/1997																										X
C-95	0	0.5	4/24/1997																										X
	4.5	5	4/24/1997																										X
	11.5	12	4/24/1997																										X
C-96	0	0.5	4/24/1997																										X
	3.5	4	4/24/1997																										X
	13	13.5	4/24/1997																										X
C-97	0	0.5	4/24/1997																										X
	6	6.5	4/24/1997																										X
C-98	0	0.5	4/24/1997																										X
	3.5	4	4/24/1997																										X
	7.5	8	4/24/1997																										X
CPT-21	4.5	5	11/22/1998				X				X			X		X						X					X		X
CPT-24	2.5	3	11/22/1998				X				X			X		X						X					X		X
GZA-1A	5	5.5	3/2/2005																						X		X		
GZA-2	6	6.5	3/2/2005																						X		X		
GZA-3	3.5	4	3/2/2005																						X		X		
GZA-5	6.5	7	3/2/2005																						X		X		
GZA-6	3	4	3/3/2005																						X		X		
GZA-7A	1	2	3/3/2005																						X		X		
GZA-7B	1.5	2	3/3/2005																						X		X		
GZA-8	1	1.5	3/3/2005																						X		X		
GZA-9	1	1.5	3/3/2005																						X		X		
GZA-10	5	unk	3/3/2005																						X		X		
GZA-11	1	3	7/7/2005											X															
GZA-12	1.5	2	7/18/2005											X															
GZA-14	4	5	7/7/2005											X															
GZA-15	4	5	7/7/2005											X								X							
GZA-16	4	6	7/7/2005											X													X		

306162

TABLE 2-2

Soil Sample Analytical Method Summary  
 Quanta Resources Superfund Site, OU1  
 Edgewater, New Jersey

				Parameter																											
Location	Start Depth (ft bgs)	End Depth (ft bgs)	Sampling Date	Ammonia	Atterberg Limits	Chromium (VI)	Cyanide	Grain Size	Leaching Procedure	Leaching Procedure - Metals Only	Metals	Mercury	Oil & Grease	PCBs	Percent Moisture	Pesticides	Petrographic	pH	Phenolics	Porosity	Redox Potential	SVOCs	Total Organic Carbon	Fraction Organic Carbon	Total Solids	TPH	VOCs	X-Ray Diffraction	Unknown*		
GZA-17	2	3	7/7/2005																			X						X			
GZA-18	4	5	7/7/2005																			X						X			
GZA-19	2	3	7/7/2005			X					X	X		X								X									
	4	6	7/7/2005																									X			
GZA-20	8	9	7/8/2005			X					X	X		X								X						X			
GZA-21	4	4.5	7/6/2005			X					X	X										X						X			
GZA-22	2	3	7/6/2005			X					X	X										X									
	4	4.5	7/6/2005																									X			
GZA-23	4	6	7/6/2005			X					X	X										X						X			
GZA-24	2	3	7/6/2005			X					X	X										X							X		
	4	4.5	7/6/2005																									X			
GZA-25	2	2.5	7/6/2005																									X			
	2	3	7/6/2005			X					X	X										X									
GZA-26	2	3	7/8/2005			X					X	X		X								X						X			
GZA-27	2	3	7/8/2005			X					X	X		X								X						X			
GZA-28	2	3	7/7/2005			X					X	X		X								X						X			
GZA-29	4	5	7/7/2005			X					X	X		X								X						X			
GZA-30	7	7.5	7/7/2005			X					X	X		X								X						X			
	15	17	7/7/2005			X					X	X		X								X						X			
GZA-31	2	4	7/7/2005			X					X	X		X								X						X			
GZA-32	2	4	7/7/2005			X					X	X		X								X						X			
GZA-33	2	4	7/6/2005			X					X	X										X						X			
GZA-34	3.5	4	7/7/2005											X																	
GZA-35	3.5	4	7/7/2005											X																	
GZA-36	3.5	4	7/7/2005											X																	
GZA-37	3.5	4	7/7/2005											X																	
GZA-38	3.5	4	7/7/2005											X																	
GZA-39	5	5.5	7/19/2005			X					X	X										X						X			
GZA-40	6	8	7/8/2005			X					X	X										X						X			
GZA-41	3.5	4	7/19/2005			X					X	X										X						X			
GZA-42	5	5.5	7/6/2005			X					X	X										X						X			
GZA-43	19.5	20	7/6/2005			X					X	X										X						X			
	4.5	5	7/6/2005																									X			
	4	4.5	7/6/2005			X					X	X										X									
	5	unk	7/6/2005																									X			

Soil Sample Analytical Method Summary  
Quanta Resources Superfund Site, OU1  
Edgewater, New Jersey

306164  
Page 11 of 27

TABLE 2-2

Soil Sample Analytical Method Summary

Quanta Resources Superfund Site, OU1

Edgewater, New Jersey

				Parameter																										
Location	Start Depth (ft bgs)	End Depth (ft bgs)	Sampling Date	Ammonia	Atterberg Limits	Chromium (VI)	Cyanide	Grain Size	Leaching Procedure	Leaching Procedure - Metals Only	Metals	Mercury	Oil & Grease	PCBs	Percent Moisture	Pesticides	Petrographic	pH	Phenolics	Porosity	Redox Potential	SVOCs	Total Organic Carbon	Fraction Organic Carbon	Total Solids	TPH	VOCs	X-Ray Diffraction	Unknown*	
HD-2B	7.5	8	4/2/1997																											X
	13.5	14	4/2/1997																											X
HD-2C	5.5	6	4/7/1997																											X
	14.5	15	4/7/1997																											X
HD-2D	7.5	8	4/2/1997																											X
	12.5	13	4/2/1997																											X
HD-2E	7.5	8	4/2/1997																											X
	12.5	13	4/2/1997																											X
HD-2F	8	8.5	4/3/1997																											X
	13.5	14	4/3/1997																											X
HD-3C	5.5	6	4/2/1997																											X
	13	13.5	4/2/1997																											X
HD-3D	7.5	8	4/2/1997																											X
	13.5	14	4/2/1997																											X
HF-2	0	0.5	3/4/1997																											X
	7.5	8	3/4/1997																											X
HF-3	9	9.5	3/4/1997																											X
	13.5	14	3/4/1997																											X
HF-4	8	8.5	3/6/1997																											X
	13.5	14	3/6/1997																											X
HF-5	10.5	11	3/4/1997																											X
	14.5	15	3/4/1997																											X
LB-1A	5	5.5	3/17/1997																											X
	9	9.5	3/17/1997																											X
LB-1B	5	5.5	3/17/1997																											X
	9	9.5	3/17/1997																											X
LB-1C	5	5.5	3/17/1997																											X
	9	9.5	3/17/1997																											X
LB-2A	1	1.5	2/26/1997																											X
LB-2B	1	1.5	2/26/1997																											X
LB-2C	1	1.5	2/26/1997																											X
LB-3A	9	9.5	2/28/1997																											X
	13.5	14	2/28/1997																											X
LB-3B	6	6.5	2/28/1997																											X
	11.5	12	2/28/1997																											X
LB-3C	9	9.5	2/27/1997																											X
	14.5	15	2/27/1997																											X

TABLE 2-2

Soil Sample Analytical Method Summary  
 Quanta Resources Superfund Site, OU1  
 Edgewater, New Jersey

				Parameter																										
Location	Start Depth (ft bgs)	End Depth (ft bgs)	Sampling Date	Ammonia	Atterberg Limits	Chromium (VI)	Cyanide	Grain Size	Leaching Procedure	Leaching Procedure - Metals Only	Metals	Mercury	Oil & Grease	PCBs	Percent Moisture	Pesticides	Petrographic	pH	Phenolics	Porosity	Redox Potential	SVOCs	Total Organic Carbon	Fraction Organic Carbon	Total Solids	TPH	VOCs	X-Ray Diffraction	Unknown*	
LB-3D	9	9.5	2/27/1997																											X
	15.5	16	2/27/1997																											X
LD-1	5.5	6	3/5/1997																											X
	11.5	12	3/5/1997																											X
LHA-1A	0.5	1	3/5/1997																											X
	7.5	8	3/5/1997																											X
LHA-1B	2	2.5	4/2/1997																											X
	7	7.5	4/2/1997																											X
LHA-1C	2.5	3	4/2/1997																											X
	7.5	8	4/2/1997																											X
LHA-1D	0	0.5	4/2/1997																											X
	2.5	3	4/2/1997																											X
	7.5	8	4/2/1997																											X
LHA-1E	0	0.5	4/2/1997																											X
	3	3.5	4/2/1997																											X
	7.5	8	4/2/1997																											X
MW-44	20	20	7/19/2005			X					X	X											X					X		
MW-49	8	8	3/9/2006												X								X					X		
MW-50	6	6	3/9/2006												X								X					X		
MW-51	unk	unk	6/21/2006																				X					X		
MW-52	unk	unk	6/21/2006																				X					X		
MW-53	unk	unk	6/21/2006																				X					X		
MW-C	16.5	17	5/3/2004								X																			
MW-E	13.5	14	5/3/2004								X																			
MW-F	13.5	14	5/3/2004								X																			
P-1	8.5	9	5/8/2003				X				X	X		X		X							X					X		
P-2	9	9.5	5/8/2003				X				X	X		X		X							X					X		
P-3	9	9.5	5/8/2003				X				X	X		X		X							X					X		
P-4	9.5	10	5/12/2003				X				X	X		X		X							X					X		
P-5	9.5	10	5/12/2003				X				X	X		X		X							X					X		
P-6	8.73	9.23	5/13/2003				X				X	X		X		X							X					X		
P-7	7.5	8	5/13/2003				X				X	X		X		X							X					X		
P-8	8.85	9.35	5/13/2003				X				X	X		X		X							X					X		
P-9	8.85	9.35	5/13/2003				X				X	X		X		X							X					X		
PB-1	3.5	4	3/3/1997																											X
	11.5	12	3/3/1997																											X

TABLE 2-2

Soil Sample Analytical Method Summary  
 Quanta Resources Superfund Site, OU1  
 Edgewater, New Jersey

				Parameter																										
Location	Start Depth (ft bgs)	End Depth (ft bgs)	Sampling Date	Ammonia	Atterberg Limits	Chromium (VI)	Cyanide	Grain Size	Leaching Procedure	Leaching Procedure - Metals Only	Metals	Mercury	Oil & Grease	PCBs	Percent Moisture	Pesticides	Petrographic	pH	Phenolics	Porosity	Redox Potential	SVOCs	Total Organic Carbon	Fraction Organic Carbon	Total Solids	TPH	VOCs	X-Ray Diffraction	Unknown*	
PB-2	3	3.5	3/3/1997																											X
	10.5	11	3/3/1997																											X
PB-3	2	2.5	3/3/1997																											X
	11.5	12	3/3/1997																											X
PB-4	1	1.5	2/28/1997																											X
	5.5	6	2/28/1997																											X
PB-5	0.5	1	2/28/1997																											X
	6.5	7	2/28/1997																											X
PB-6	0.5	1	3/4/1997																											X
	7.5	8	3/4/1997																											X
PB-7	2	2.5	3/5/1997																											X
	8.5	9	3/5/1997																											X
PB-8	1	1.5	3/5/1997																											X
	8.5	9	3/5/1997																											X
QE001	0	0	3/27/1992																											X
QE002	0	0	3/27/1992																											X
QE003	0	0	3/27/1992																											X
QE004	0	0	3/27/1992																											X
QE005	0	0	3/27/1992																											X
QR-01	0	0	3/27/1996						X																					X
QR-02	1.5	2	3/27/1996						X																					X
QR-03	0	1	3/27/1996						X																					X
QR-04	unk	unk	3/27/1996						X																					X
SB-1	1	1.5	12/11/2005			X					X			X	X								X					X		
	9	10	12/11/2005			X					X			X	X								X					X		
	14	15	12/11/2005			X					X			X	X								X					X		
SB-2	0	0.16	8/18/2005			X					X			X	X								X					X		
	9.5	10	8/18/2005			X					X			X	X								X					X		
	29	30	8/18/2005			X					X			X	X								X					X		
SB-3	0	0.16	8/22/2005			X					X			X	X								X					X		
	3.5	4	8/22/2005			X		X			X			X	X								X					X		
	11	12	8/22/2005			X					X			X	X								X					X		
	21	22	8/22/2005			X					X			X	X								X					X		
SB-4	1	1.5	12/10/2005			X					X			X	X								X					X		
	3	3.5	12/10/2005			X		X			X			X	X								X					X		
	14	15	12/10/2005			X					X			X	X								X					X		
	29.5	30	12/10/2005			X					X			X	X								X					X		

TABLE 2-2

Soil Sample Analytical Method Summary  
 Quanta Resources Superfund Site, OU1  
 Edgewater, New Jersey

Location	Start Depth (ft bgs)	End Depth (ft bgs)	Sampling Date	Parameter																									
				Ammonia	Atterberg Limits	Chromium (VI)	Cyanide	Grain Size	Leaching Procedure	Leaching Procedure - Metals Only	Metals	Mercury	Oil & Grease	PCBs	Percent Moisture	Pesticides	Petrographic	pH	Phenolics	Porosity	Redox Potential	SVOCs	Total Organic Carbon	Fraction Organic Carbon	Total Solids	TPH	VOCs	X-Ray Diffraction	Unknown*
SB-5	11	11.7	8/10/2005					X							X					X				X					
	22	24	7/28/2005			X					X			X	X							X					X		
SB-6	0	1	8/2/2005			X					X			X	X							X					X		
	1.5	2	8/2/2005			X		X			X			X	X							X					X		
	9.5	10.1	8/10/2005					X							X					X				X					
	23	24	8/2/2005			X					X			X	X							X					X		
SB-7	0	0.16	8/17/2005			X					X			X	X							X					X		
	16.5	17	8/17/2005			X					X			X	X							X					X		
	23	24	8/17/2005			X					X			X	X							X					X		
SB-8	1	1.5	10/9/2005			X					X			X	X							X		X			X		
	8.5	9	10/9/2005			X					X			X	X							X					X		
	24	25	10/9/2005			X					X			X	X							X					X		
SB-9	0	0.16	8/18/2005			X					X			X	X							X					X		
	0.8	1.3	8/18/2005			X					X			X	X							X					X		
	9.5	10	8/18/2005			X					X			X	X							X					X		
	27.5	28	8/18/2005			X					X			X	X							X					X		
SB-10	0	0.16	8/23/2005			X					X	X		X	X							X					X		
	3	4	8/23/2005			X					X	X		X	X							X					X		
	25.5	26	8/23/2005			X					X	X		X	X							X					X		
SB-11	0	0.16	8/23/2005			X	X				X	X		X	X							X					X		
	1.5	2	8/23/2005			X	X				X	X		X	X							X					X		
	4.5	5	8/23/2005			X	X				X	X		X	X							X					X		
	23.2	24	8/23/2005			X	X				X	X		X	X							X					X		
SB-12	0	0.16	10/25/2005	X		X					X	X		X	X							X					X		
	22.5	23	10/25/2005	X		X					X	X		X	X							X					X		
	29.5	30	10/25/2005	X		X					X	X		X	X							X					X		
SB-13	0	1	8/3/2005	X		X	X				X	X		X	X							X					X		
	1	2	8/3/2005	X		X	X	X			X	X		X	X							X					X		
	11	12	8/3/2005	X		X	X				X	X		X	X							X					X		
SB-14	0	0.16	10/24/2005	X		X					X			X	X							X					X		
	0.16	0.5	10/24/2005	X		X					X			X	X							X					X		
	22.5	23	10/24/2005	X		X					X			X	X							X					X		
SB-15	0	0.16	10/25/2005	X		X					X	X		X	X							X					X		
	7	7.5	10/25/2005	X		X					X	X		X	X							X					X		
	28.5	29	10/25/2005	X		X					X	X		X	X							X					X		

TABLE 2-2

Soil Sample Analytical Method Summary  
 Quanta Resources Superfund Site, OU1  
 Edgewater, New Jersey

				Parameter																										
Location	Start Depth (ft bgs)	End Depth (ft bgs)	Sampling Date	Ammonia	Atterberg Limits	Chromium (VI)	Cyanide	Grain Size	Leaching Procedure	Leaching Procedure - Metals Only	Metals	Mercury	Oil & Grease	PCBs	Percent Moisture	Pesticides	Petrographic	pH	Phenolics	Porosity	Redox Potential	SVOCs	Total Organic Carbon	Fraction Organic Carbon	Total Solids	TPH	VOCs	X-Ray Diffraction	Unknown*	
SB-16	0	0.16	11/9/2005			X					X			X	X								X					X		
	16.5	17	11/15/2005			X					X			X	X								X					X		
	26	27	11/15/2005			X					X			X	X								X					X		
SB-17	0.3	0.5	12/10/2005			X					X			X	X								X					X		
	4	5	12/10/2005			X		X			X			X	X								X					X		
	9	10	12/10/2005			X					X			X	X								X					X		
	27	28	12/10/2005			X					X			X	X								X					X		
SB-18	0	0.16	11/10/2005			X					X			X	X								X					X		
	26	26.5	11/18/2005			X					X			X	X								X					X		
SB-19	1	3	10/12/2006								X	X											X					X		
	4	6	10/12/2006								X	X											X					X		
SB-20	5	7	10/12/2006								X	X																		
	19	20	10/12/2006								X	X																		
SB-21	1	3	10/13/2006								X	X											X					X		
	5	7	10/13/2006								X	X											X					X		
SB-22	1	3	10/13/2006			X					X	X		X				X				X	X					X		
	15	17	10/13/2006			X					X	X						X				X	X					X		
SB-23	0	2	10/18/2006											X																
	2	4	10/18/2006								X	X		X									X					X		
	10	12	10/18/2006								X	X											X					X		
SB-24	0	2	10/16/2006			X					X	X						X				X	X					X		
	10	12	10/16/2006			X					X	X						X				X	X					X		
SB-25	0	2	10/17/2006																				X					X		
	7	9	10/17/2006																				X					X		
SB-26	13	15	10/13/2006			X					X	X						X				X	X					X		
SB-27	0	2	10/13/2006																				X					X		
	9	10	10/13/2006																				X					X		
SB-28	2.9	3.9	6/5/2007							X	X							X						X					X	
	6	7	6/5/2007								X							X					X	X					X	
SB-29	0.8	2.9	6/5/2007								X							X											X	
	5.0	8.4	6/5/2007								X							X					X						X	
SB-30	1.5	3.5	6/5/2007							X	X							X					X	X				X	X	
	4.0	15	6/5/2007								X							X						X					X	
SB-31	0.0	2.2	6/5/2007							X	X							X						X					X	
	4.5	7.6	6/5/2007								X							X						X					X	
SB-34	0.9	1.6	6/4/2007							X	X							X						X					X	



TABLE 2-2

Soil Sample Analytical Method Summary  
 Quanta Resources Superfund Site, OU1  
 Edgewater, New Jersey

Location	Start Depth (ft bgs)	End Depth (ft bgs)	Sampling Date	Parameter																									
				Ammonia	Atterberg Limits	Chromium (VI)	Cyanide	Grain Size	Leaching Procedure	Leaching Procedure - Metals Only	Metals	Mercury	Oil & Grease	PCBs	Percent Moisture	Pesticides	Petrographic	pH	Phenolics	Porosity	Redox Potential	SVOCs	Total Organic Carbon	Fraction Organic Carbon	Total Solids	TPH	VOCs	X-Ray Diffraction	Unknown*
SB-36	0.8	1.2	6/6/2007								X						X						X					X	
	1.2	2.2	6/6/2007							X	X						X						X					X	
	3.2	5.2	6/6/2007								X						X						X					X	
	5.9	6.7	6/6/2007								X						X						X					X	
SB-37	3.9	5.0	6/6/2007								X						X						X					X	
SB-38	1.7	3.4	6/6/2007							X	X						X						X					X	
	3.4	7.3	6/6/2007								X						X						X					X	
	9.4	9.6	6/6/2007								X						X						X					X	
SB-101	6	7	11/17/1998								X												X			X			
	13	14	11/17/1998								X												X			X			
SB-101DS	0	0.16	8/30/2005	X		X					X			X	X	X							X				X		
	3.5	4	8/30/2005	X		X		X			X			X	X	X							X				X		
	16.2	16.7	8/30/2005	X		X					X			X	X	X							X				X		
	25	25.5	8/31/2005	X		X					X			X	X	X							X				X		
	47	47.5	9/1/2005			X					X			X	X								X				X		
SB-102	13	14	11/16/1998								X												X			X			
	21	22	11/16/1998								X												X			X			
SB-102B	0	0.16	7/25/2005			X					X			X	X								X				X		
	2.67	3.67	7/25/2005			X		X			X			X	X								X				X		
	24	26	7/26/2005			X					X			X	X								X				X		
SB-103	0	1	11/11/1998								X												X			X			
	3	4	11/11/1998								X												X			X			
	9	10	11/11/1998								X												X			X			
	13	14	11/11/1998								X												X			X			
	21	22	11/11/1998								X												X			X			
											X												X			X			
SB-103DS	0	0.16	8/26/2005			X					X			X	X	X							X				X		
	1.4	1.9	8/26/2005			X		X			X			X	X	X							X				X		
	5	6	8/26/2005			X					X			X	X	X							X				X		
	21.5	22	8/26/2005			X					X			X	X	X							X				X		
	51	52	8/29/2005			X					X			X	X								X				X		
SB-105	5	5	6/18/1999																										X
	19	20	6/18/1999																										X
SB-105A	3.4	3.6	8/22/2005			X					X			X	X								X				X		
	3.6	3.9	8/22/2005			X					X			X	X								X				X		
	9	10	8/22/2005			X					X			X	X								X				X		
	17	18	8/22/2005		X	X					X			X	X								X				X		

TABLE 2-2

Soil Sample Analytical Method Summary

Quanta Resources Superfund Site, OU1

Edgewater, New Jersey

				Parameter																										
Location	Start Depth (ft bgs)	End Depth (ft bgs)	Sampling Date	Ammonia	Atterberg Limits	Chromium (VI)	Cyanide	Grain Size	Leaching Procedure	Leaching Procedure - Metals Only	Metals	Mercury	Oil & Grease	PCBs	Percent Moisture	Pesticides	Petrographic	pH	Phenolics	Porosity	Redox Potential	SVOCs	Total Organic Carbon	Fraction Organic Carbon	Total Solids	TPH	VOCs	X-Ray Diffraction	Unknown*	
SB-106	9	10	6/21/1999																											X
	14	15	6/21/1999																											X
	18	19	6/21/1999																											X
	23	24	6/21/1999																											X
SB-106A	0	0.16	11/9/2005			X					X			X	X								X					X		
	11.5	12	11/9/2005			X					X			X	X								X					X		
	18.5	19	11/18/2005			X					X			X	X								X					X		
SB-107	13	14	6/23/1999																											X
	17	18	6/23/1999																											X
	23	23.5	6/23/1999																											X
SB-107DS	0	0.16	11/16/2005			X					X			X	X								X					X		
	3.5	4	11/16/2005			X					X			X	X								X					X		
	19.5	20	11/16/2005			X					X			X	X								X					X		
	24	25	11/16/2005			X					X			X	X								X					X		
	61	61.5	11/17/2005			X					X			X	X								X					X		
SB-108	2	2.5	6/21/1999																											X
	11	12	6/21/1999																											X
SB-109A	0	0.16	11/8/2005			X					X			X	X								X					X		
	4.5	5	11/8/2005			X					X			X	X								X					X		
SB-109	7	7.5	6/22/1999																											X
	20	21	6/23/1999																											X
SB-110	12	13	6/24/1999																											X
	20	21	6/24/1999																											X
	24	25	6/24/1999																											X
SB-111A	1.7	2	8/4/2005	X		X					X			X	X	X							X					X		
	3.8	4	8/4/2005	X		X		X			X			X	X	X							X					X		
	10.7	12	8/4/2005	X		X					X			X	X	X							X					X		
	29.5	30	8/4/2005	X		X					X			X	X	X							X					X		
SB-112A	0	0.16	8/15/2005	X		X					X			X	X	X							X					X		
	1.8	2	8/15/2005	X		X					X			X	X	X							X					X		
SB-112B	13	15	7/27/2005	X		X					X			X	X								X					X		
SB-113C	0	0.16	11/22/2005			X					X			X	X	X							X					X		
SB-114B	1.5	2	1/14/2006			X					X			X	X								X					X		
	8.5	9	1/14/2006			X					X			X	X								X					X		
	24.2	25	1/14/2006			X					X			X	X								X					X		

TABLE 2-2

Soil Sample Analytical Method Summary  
 Quanta Resources Superfund Site, OU1  
 Edgewater, New Jersey

				Parameter																										
Location	Start Depth (ft bgs)	End Depth (ft bgs)	Sampling Date	Ammonia	Atterberg Limits	Chromium (VI)	Cyanide	Grain Size	Leaching Procedure	Leaching Procedure - Metals Only	Metals	Mercury	Oil & Grease	PCBs	Percent Moisture	Pesticides	Petrographic	pH	Phenolics	Porosity	Redox Potential	SVOCs	Total Organic Carbon	Fraction Organic Carbon	Total Solids	TPH	VOCs	X-Ray Diffraction	Unknown*	
SB-115B	0	0.16	2/14/2006			X					X			X	X								X					X		
	3.5	4	2/14/2006			X					X			X	X								X					X		
	11.5	12	2/14/2006			X					X			X	X								X					X		
	27	28	2/14/2006			X					X			X	X								X					X		
SB-116B	0	0.16	8/16/2005			X					X			X	X								X					X		
	1.75	2	8/16/2005			X		X			X			X	X								X					X		
	4.5	5	8/16/2005			X					X			X	X								X					X		
	14.5	15	8/16/2005		X	X					X			X	X								X					X		
SB-117B	0	0.16	7/26/2005			X					X			X	X								X					X		
	4	5.5	7/26/2005			X					X			X	X								X					X		
	15	18	7/26/2005		X	X					X			X	X								X					X		
SB-118B	0	0.16	7/25/2005			X					X			X	X								X					X		
	6.5	7	7/25/2005			X					X			X	X								X					X		
	16	17	7/25/2005		X	X					X			X	X								X					X		
SB-119A	14.5	15	10/8/2005			X					X			X	X								X					X		
SB-119B	14.5	15	10/8/2005			X					X			X	X								X					X		
	9.5	10	10/8/2005			X					X			X	X								X					X		
SB-120B	0	0.16	11/11/2005			X					X			X	X								X					X		
	3.5	4	11/11/2005		X	X		X			X			X	X								X					X		
	18	19	11/11/2005			X					X			X	X								X					X		
SB-121B	21	22	1/15/2006			X					X			X	X								X					X		
	23	24	1/15/2006			X					X			X	X								X					X		
SB-122A	0	0.16	11/10/2005			X					X			X	X								X					X		
SB-R27	1	1.5	4/30/2004				X				X	X		X		X							X					X		
	10	10.5	4/30/2004				X				X	X		X		X							X					X		
	35.5	36	4/30/2004				X				X	X		X		X							X					X		
SB-S26.5	0	0.5	4/29/2004				X				X	X		X		X							X					X		
	11.5	12	4/29/2004				X				X	X		X		X							X					X		
	28.5	29	4/29/2004				X				X	X		X		X							X					X		
SB-S26	0	0.5	4/28/2004				X				X	X		X		X							X					X		
	12.5	13	4/28/2004				X				X	X		X		X							X					X		
	26.5	27	4/28/2004				X				X	X		X		X							X					X		
SB-S27	0	0.5	4/28/2004				X				X	X		X		X							X					X		
	10.5	11	4/28/2004				X				X	X		X		X							X					X		
	25.5	26	4/28/2004				X				X	X		X		X							X					X		

TABLE 2-2

Soil Sample Analytical Method Summary

Quanta Resources Superfund Site, OU1

Edgewater, New Jersey

Location	Start Depth (ft bgs)	End Depth (ft bgs)	Sampling Date	Parameter																									
				Ammonia	Atterberg Limits	Chromium (VI)	Cyanide	Grain Size	Leaching Procedure	Leaching Procedure - Metals Only	Metals	Mercury	Oil & Grease	PCBs	Percent Moisture	Pesticides	Petrographic	pH	Phenolics	Porosity	Redox Potential	SVOCs	Total Organic Carbon	Fraction Organic Carbon	Total Solids	TPH	VOCs	X-Ray Diffraction	Unknown*
SB-S28	0	0.5	4/28/2004				X				X	X		X		X						X					X		
	11.5	12	4/29/2004				X				X	X		X		X						X					X		
	35.5	36	4/29/2004				X				X	X		X		X						X					X		
SB-S29	12	12.5	4/30/2004				X				X	X		X		X						X					X		
	39.5	40	4/30/2004				X				X	X		X		X						X					X		
SB-T12	0	0.5	2/14/2003				X				X	X		X		X						X					X		
	11	11.5	2/14/2003				X				X	X		X		X						X					X		
	14	14.5	2/14/2003				X				X	X		X		X						X					X		
SB-T15	0	0.5	2/24/2003				X				X	X		X		X						X					X		
	8	8.5	2/24/2003				X				X	X		X		X						X					X		
SB-T18	0	0.5	2/20/2003				X				X	X		X		X						X					X		
	11.5	12	2/20/2003				X				X	X		X		X						X					X		
SB-T21	0	0.5	2/20/2003				X				X	X		X		X						X					X		
	11.5	12	2/20/2003				X				X	X		X		X						X					X		
	15.5	16	2/20/2003				X				X	X		X		X						X					X		
SB-T24	0	0.5	2/21/2003				X				X	X		X		X						X					X		
	23	23.5	2/21/2003				X				X	X		X		X						X					X		
SB-T26	0	0.5	2/21/2003				X				X	X		X		X						X					X		
	8.5	9	2/21/2003				X				X	X		X		X						X					X		
	30.5	31	2/21/2003				X				X	X		X		X						X					X		
SB-T27	0	0.5	4/28/2004				X				X	X		X		X						X					X		
	11.5	12	4/28/2004				X				X	X		X		X						X					X		
	29.5	30	4/28/2004				X				X	X		X		X						X					X		
SB-T28	0	0.5	2/24/2003				X				X	X		X		X						X					X		
	8	11	2/24/2003				X				X	X		X		X						X					X		
	15.5	16	2/24/2003				X				X	X		X		X						X					X		
	28	28.5	2/24/2003																								X		
	37.5	38	2/24/2003				X				X	X		X		X						X					X		
SB-U21	0	0.5	5/6/2003				X				X	X		X		X						X					X		
	7.5	8	5/6/2003				X				X	X		X		X						X					X		
	11.5	12	5/6/2003				X				X	X		X		X						X					X		
SB-V11	8.5	9	4/3/2003				X				X	X		X		X						X					X		
	19.5	20	4/3/2003				X				X	X		X		X						X					X		
SB-V12	6	6.5	4/3/2003				X				X	X		X		X						X					X		
	16.5	17	4/3/2003				X				X	X		X		X						X					X		

TABLE 2-2

Soil Sample Analytical Method Summary  
 Quanta Resources Superfund Site, OU1  
 Edgewater, New Jersey

Location	Start Depth (ft bgs)	End Depth (ft bgs)	Sampling Date	Parameter																									
				Ammonia	Atterberg Limits	Chromium (VI)	Cyanide	Grain Size	Leaching Procedure	Leaching Procedure - Metals Only	Metals	Mercury	Oil & Grease	PCBs	Percent Moisture	Pesticides	Petrographic	pH	Phenolics	Porosity	Redox Potential	SVOCs	Total Organic Carbon	Fraction Organic Carbon	Total Solids	TPH	VOCs	X-Ray Diffraction	Unknown*
SB-V21	0	0.5	4/25/2003				X				X	X		X		X						X					X		
	8	8.5	4/25/2003				X				X	X		X		X						X					X		
	15.5	16	4/25/2003				X				X	X		X		X						X					X		
SB-V24	0	0.5	5/8/2003				X				X	X		X		X						X					X		
	9	9.5	5/8/2003				X				X	X		X		X						X					X		
	23.5	24	5/8/2003				X				X	X		X		X						X					X		
SB-V26	0	0.5	5/6/2003				X				X	X		X		X						X					X		
	14	14.5	5/6/2003				X				X	X		X		X						X					X		
	24	24.5	5/6/2003				X				X	X		X		X						X					X		
SB-W10	5	5.5	4/3/2003				X				X	X		X		X						X					X		
	11.5	12	4/3/2003				X				X	X		X		X						X					X		
	21.5	22	4/3/2003				X				X	X		X		X						X					X		
SB-W11	0	0.5	2/20/2003				X				X	X		X		X						X					X		
	8	8.5	2/20/2003								X	X																	
	12	12.5	2/20/2003				X				X	X		X		X						X					X		
	23.5	24	2/20/2003				X				X	X		X		X						X					X		
SB-W12	9.5	10	4/3/2003				X				X	X		X		X						X					X		
	19.5	20	4/3/2003				X				X	X		X		X						X					X		
SB-W13	0	0.5	2/14/2003				X				X	X		X		X						X					X		
	12	12.5	2/14/2003				X				X	X		X		X						X					X		
	19	19.5	2/14/2003				X				X	X		X		X						X					X		
SB-W15	0	0.5	2/14/2003				X				X	X		X		X						X					X		
	11.5	12	2/14/2003				X				X	X		X		X						X					X		
	16.5	17	2/14/2003				X				X	X		X		X						X					X		
SB-W18	0	0.5	4/25/2003				X				X	X		X		X						X					X		
	2	2.5	4/25/2003				X				X	X		X		X						X					X		
	16.5	17	4/25/2003				X				X	X		X		X						X					X		
SB-W21	0	0.5	5/6/2003				X				X	X		X		X						X					X		
	9	9.5	5/6/2003				X				X	X		X		X						X					X		
	14.5	15	5/6/2003				X				X	X		X		X						X					X		
SB-W24	0	0.5	4/23/2003				X				X	X		X		X						X					X		
	13	13.5	4/23/2003				X				X	X		X		X						X					X		
	24.5	25	4/23/2003				X				X	X		X		X						X					X		
SB-W26	0	0.5	4/23/2003				X				X	X		X		X						X					X		
	13	13.5	4/23/2003				X				X	X		X		X						X					X		
SB-W26	23.5	24	4/23/2003				X				X	X		X		X						X					X		

TABLE 2-2

Soil Sample Analytical Method Summary  
 Quanta Resources Superfund Site, OU1  
 Edgewater, New Jersey

				Parameter																										
Location	Start Depth (ft bgs)	End Depth (ft bgs)	Sampling Date	Ammonia	Atterberg Limits	Chromium (VI)	Cyanide	Grain Size	Leaching Procedure	Leaching Procedure - Metals Only	Metals	Mercury	Oil & Grease	PCBs	Percent Moisture	Pesticides	Petrographic	pH	Phenolics	Porosity	Redox Potential	SVOCs	Total Organic Carbon	Fraction Organic Carbon	Total Solids	TPH	VOCs	X-Ray Diffraction	Unknown*	
SB-X10	5.5	6	4/3/2003				X				X	X		X		X							X					X		
	17.5	18	4/3/2003				X				X	X		X		X							X					X		
SB-X11	0	0.5	2/21/2003				X				X	X		X		X							X					X		
	10.5	11	2/21/2003				X				X	X		X		X							X					X		
	26.5	27	2/21/2003				X				X	X		X		X							X					X		
SB-X12	0	0.5	4/4/2003				X				X	X		X		X							X					X		
	8	8.5	4/4/2003				X				X	X		X		X							X					X		
	24.5	25	4/4/2003				X				X	X		X		X							X					X		
SB-X13	0	0.5	2/24/2003				X				X	X		X		X							X					X		
	8	8.5	2/24/2003				X				X	X		X		X							X					X		
	23.5	24	2/24/2003				X				X	X		X		X							X					X		
SB-X15	0	0.5	4/21/2003				X				X	X		X		X							X					X		
	6	6.5	4/21/2003				X				X	X		X		X							X					X		
	8	8.5	4/21/2003				X				X	X		X		X							X					X		
	22	22.5	4/21/2003				X				X	X		X		X							X					X		
SB-X18	0	0.5	5/6/2003				X				X	X		X		X							X					X		
	6	6.5	5/6/2003				X				X	X		X		X							X					X		
	17.5	18	5/7/2003				X				X	X		X		X							X					X		
SB-Y13	0	0.5	4/4/2003				X				X	X		X		X							X					X		
	8	8.5	4/4/2003				X				X	X		X		X							X					X		
	26.5	27	4/4/2003				X				X	X		X		X							X					X		
SF-3A	0	0.5	2/24/1997																											X
	3	3.5	3/17/1997																											X
	5.5	6	2/24/1997																											X
SF-3B	0	0.5	2/24/1997																											X
	3	3.5	2/24/1997																											X
	5.5	6	2/24/1997																											X
SF-3C	0	0.5	2/24/1997																											X
	3	3.5	2/24/1997																											X
	5.5	6	2/24/1997																											X
SF-4A	0	0.5	2/24/1997																											X
	3	3.5	2/24/1997																											X
	5.5	6	2/24/1997																											X
SF-4B	0	0.5	2/24/1997																											X
	3	3.5	2/24/1997																											X
	5.5	6	2/24/1997																											X

TABLE 2-2

Soil Sample Analytical Method Summary  
 Quanta Resources Superfund Site, OU1  
 Edgewater, New Jersey

				Parameter																										
Location	Start Depth (ft bgs)	End Depth (ft bgs)	Sampling Date	Ammonia	Atterberg Limits	Chromium (VI)	Cyanide	Grain Size	Leaching Procedure	Leaching Procedure - Metals Only	Metals	Mercury	Oil & Grease	PCBs	Percent Moisture	Pesticides	Petrographic	pH	Phenolics	Porosity	Redox Potential	SVOCs	Total Organic Carbon	Fraction Organic Carbon	Total Solids	TPH	VOCs	X-Ray Diffraction	Unknown*	
SF-4C	0	0.5	2/24/1997																											X
	3	3.5	2/24/1997																											X
	5.5	6	2/24/1997																											X
SF-4D	0	0.5	2/24/1997																											X
	3	3.5	2/24/1997																											X
	5.5	6	2/24/1997																											X
SF-6A	0	0.5	2/21/1997																											X
	3	3.5	2/21/1997																											X
	5.5	6	2/21/1997																											X
SF-6B	0	0.5	2/21/1997																											X
	3	3.5	2/21/1997																											X
	5.5	6	2/21/1997																											X
SF-6C	0	0.5	2/21/1997																											X
	3	3.5	2/21/1997																											X
	5.5	6	2/21/1997																											X
SF-6D	0	0.5	2/21/1997																											X
	3	3.5	2/21/1997																											X
	5.5	6	2/21/1997																											X
SF-8A	8	8.5	3/6/1997																											X
	13	13.5	3/6/1997																											X
SF-8B	9	9.5	3/6/1997																											X
	14.5	15	3/6/1997																											X
SF-8C	10.5	11	3/6/1997																											X
	14.5	15	3/6/1997																											X
SLG-01	0.0	0.2	6/4/2007							X	X							X						X					X	
SS-01	0	0.5	3/10/1997																											X
SS-02	0	0.5	3/10/1997																											X
SS-03	0	0.5	3/10/1997																											X
SS-04	0	0.5	3/10/1997																											X
SS-05	0	0.5	3/10/1997																											X
SS-06	0	0.5	3/10/1997																											X
SS-13A	17	17.5	2/2/2006																				X							
SS-13B	14.5	15	2/2/2006																				X							
SS-13C	13.5	14	2/7/2006																				X							
	14.5	15	2/7/2006																				X							

TABLE 2-2

Soil Sample Analytical Method Summary

Quanta Resources Superfund Site, OU1

Edgewater, New Jersey

Location	Start Depth (ft bgs)	End Depth (ft bgs)	Sampling Date	Parameter																									
				Ammonia	Atterberg Limits	Chromium (VI)	Cyanide	Grain Size	Leaching Procedure	Leaching Procedure - Metals Only	Metals	Mercury	Oil & Grease	PCBs	Percent Moisture	Pesticides	Petrographic	pH	Phenolics	Porosity	Redox Potential	SVOCs	Total Organic Carbon	Fraction Organic Carbon	Total Solids	TPH	VOCs	X-Ray Diffraction	Unknown*
SS-13D	4	6	6/1/2006																			X					X		
	6	8	6/1/2006																			X					X		
	14	14.5	6/1/2006																			X					X		
	19.5	20	6/1/2006																			X					X		
SS-13E	11.5	12	6/5/2006																			X					X		
	15	15.5	6/5/2006																			X					X		
	17	18	6/5/2006																			X					X		
	19.5	20	6/5/2006																			X					X		
SS-14.5A	13	14	6/6/2006																			X					X		
SS-14A	15	16	6/2/2006																			X					X		
SS-15A	18.5	19	1/23/2006																			X							
SS-15B	15.5	16	1/23/2006																			X							
SS-15C	12	12.5	1/24/2006																			X							
	15	15.5	1/24/2006																			X							
SS-18A	12	12.5	1/25/2006																			X							
	15.5	16	1/25/2006																			X							
SS-18B	14.5	15	1/25/2006																			X							
	17.5	18	1/25/2006																			X							
SS-18C2	16.5	17	1/30/2006																			X							
SS-18C	15	15.5	1/25/2006																			X							
	16.5	17	1/25/2006																			X							
SS-18D	10	10	6/1/2006																			X							
	11	11	6/1/2006																			X							
SS-18E	11	12	6/14/2006																			X							
SS-19.5A2	11.5	12	2/9/2006																			X							
	12	12.5	2/9/2006																			X							
SS-19.5C1	10	11	5/31/2006																			X							
SS-19.5D	12	13	6/7/2006																			X							
	17	18	6/13/2006																			X							
SS-19.5E	10	12	6/13/2006																			X							
SS-19A	13	13.5	1/26/2006																			X							
SS-19B2	11.5	12	2/9/2006																			X							
SS-19C	10	10.5	5/23/2006																			X							
SS-19D	12.5	13	5/23/2006																			X							
	14	14.5	5/23/2006																			X							
SS-19E	10	11	6/14/2006																			X							
SS-22A	11.5	12	2/1/2006																			X							

306177



TABLE 2-2

Soil Sample Analytical Method Summary  
 Quanta Resources Superfund Site, OU1  
 Edgewater, New Jersey

				Parameter																										
Location	Start Depth (ft bgs)	End Depth (ft bgs)	Sampling Date	Ammonia	Atterberg Limits	Chromium (VI)	Cyanide	Grain Size	Leaching Procedure	Leaching Procedure - Metals Only	Metals	Mercury	Oil & Grease	PCBs	Percent Moisture	Pesticides	Petrographic	pH	Phenolics	Porosity	Redox Potential	SVOCs	Total Organic Carbon	Fraction Organic Carbon	Total Solids	TPH	VOCs	X-Ray Diffraction	Unknown*	
SS-22B	14	14.5	2/6/2006																			X								
SS-23A	10	14	2/3/2006																			X								
SS-23B	8.5	9	2/6/2006																			X								
	19	19.5	2/6/2006																			X								
SS-24A	9.5	10	2/9/2006																			X								
SS-24B	15	17	5/25/2006																			X								
	18.5	19	5/25/2006																			X								
SS-25A	16	17.5	5/31/2006																			X								
	21	22	5/31/2006																			X								
	24.5	25.5	5/31/2006																			X								
T-1_1	unk	unk	3/16/1998																											X
T-1_2	3	4	11/9/1998								X												X				X			
T-1_3	2	3	11/9/1998								X												X				X			
T-1_4	3	4	11/9/1998								X												X				X			
T-2_1	unk	unk	3/16/1998																											X
T-2_2	1.5	2	11/9/1998								X												X				X			
T-2_3	3	4	11/9/1998								X												X				X			
T-3_1	unk	unk	3/16/1998																											X
T-3_2	12	12.4	11/9/1998								X												X				X			
T-3_3	15	15	11/9/1998								X												X				X			
T-3_4	1	2	11/9/1998								X												X				X			
T-4_1	15.5	15.5	11/19/1998								X			X									X				X			
T-4	15.5	15.5	11/19/1998				X				X			X		X							X					X		X
T-5	unk	unk	11/20/1998																											X
	2	3	11/20/1998								X												X				X			
	8	9	11/20/1998								X												X				X			X
T-6	6	7	11/20/1998				X				X			X		X							X				X			X
T-8_1	2	2.5	11/22/1998				X				X			X		X							X					X		
T-8_2	2	3	11/22/1998				X				X			X		X							X					X		
TL10-3.5	2	4	10/10/2006											X									X					X		
	10	12	10/10/2006											X									X					X		
	25	26	10/10/2006											X									X					X		
TL11-07.5	2	4	10/10/2006											X									X					X		
	14	16	10/10/2006			X					X			X								X	X					X		
TL12-10.75	0	2	10/16/2006											X																
	13.5	15.5	10/16/2006								X	X		X									X					X		

TABLE 2-2

Soil Sample Analytical Method Summary

Quanta Resources Superfund Site, OU1

Edgewater, New Jersey

Location	Start Depth (ft bgs)	End Depth (ft bgs)	Sampling Date	Parameter																									
				Ammonia	Atterberg Limits	Chromium (VI)	Cyanide	Grain Size	Leaching Procedure	Leaching Procedure - Metals Only	Metals	Mercury	Oil & Grease	PCBs	Percent Moisture	Pesticides	Petrographic	pH	Phenolics	Porosity	Redox Potential	SVOCs	Total Organic Carbon	Fraction Organic Carbon	Total Solids	TPH	VOCs	X-Ray Diffraction	Unknown*
TL12-10.75	5.5	7.5	10/16/2006								X	X		X								X					X		
TL12-11.75	17	19	10/17/2006																			X					X		
TL12.5-11.75	21	23	10/17/2006																			X					X		
TL12.5-12.25	19	21	10/18/2006																			X					X		
TL14-09	0	2	10/11/2006											X															
	4	6	10/11/2006			X					X	X		X				X			X	X					X		
	10	12	10/11/2006											X								X					X		
TL14-10.75	1	3	10/13/2006								X	X		X								X					X		
	14	16	10/13/2006								X	X		X								X					X		
TL14-11.25	1	3	10/16/2006																			X					X		
	8.5	9	10/16/2006																			X					X		
TL15-09	0	2	10/10/2006											X															
	13	15	10/10/2006											X								X					X		
TL15-10.75	0	2	10/16/2006								X	X																	
	8	8.5	10/16/2006								X	X																	
	40.5	41.5	10/16/2006											X															
TL16-06	0	2	10/11/2006								X	X		X								X					X		
	23	25	10/11/2006								X	X		X								X					X		
TL16-07	0	2	10/11/2006			X					X	X		X				X			X	X					X		
	8	10	10/11/2006			X					X	X		X				X			X	X					X		
	8	9	10/11/2006			X					X	X		X				X			X	X					X		
TL16-09	1	3	10/11/2006								X	X		X								X					X		
	7	9	10/11/2006								X	X		X								X					X		
TL17-05	11	11.5	10/9/2006								X	X		X								X					X		
	23	25	10/9/2006								X	X		X								X					X		
TL17-06	3	5	10/12/2006			X					X	X						X			X								
TL17-07	10	12	10/12/2006			X					X	X						X			X								
TL17-08	0	2	10/12/2006			X					X	X		X				X			X	X					X		
	3	5	10/12/2006			X					X	X		X				X			X	X					X		
TL18.5-0.5	15	16.5	10/18/2006											X								X					X		
	29	30	10/18/2006											X								X					X		
TL18.5-1.5	12	13	10/9/2006											X								X					X		
	24	25	10/18/2006								X			X								X					X		
TL19-0.5	28	29.5	10/18/2006											X								X					X		
TP-10	18	18	6/21/1999																										X
TP-12	10	11	6/22/1999																										X

306179

**TABLE 2-2**

Soil Sample Analytical Method Summary  
*Quanta Resources Superfund Site, OU1*  
*Edgewater, New Jersey*

				Parameter																										
Location	Start Depth (ft bgs)	End Depth (ft bgs)	Sampling Date	Ammonia	Atterberg Limits	Chromium (VI)	Cyanide	Grain Size	Leaching Procedure	Leaching Procedure - Metals Only	Metals	Mercury	Oil & Grease	PCBs	Percent Moisture	Pesticides	Petrographic	pH	Phenolics	Porosity	Redox Potential	SVOCs	Total Organic Carbon	Fraction Organic Carbon	Total Solids	TPH	VOCs	X-Ray Diffraction	Unknown*	
TP-13	0	0	6/4/1998						X																					X
TP-14	unk	unk	6/4/1998						X																					X
TP-16	9	9	6/5/1998						X																					X
TP-5	8	8.5	6/3/1998						X																					X
TP-5	8	8	6/3/1998						X																					X
TP-6	0	0	6/3/1998						X																					X
TP01-01	0	0	3/25/1998																											X
TP01-02	0	0	3/25/1998																											X
TP02-01	0	0	3/25/1998																											X
TP02-02	unk	unk	3/25/1998																											X

**Notes:**

\*The method was marked as "Unknown" in the site database prior to 2005. Although data are available for these samples, the analytical method for some or all of the data is unknown.

ft bgs - feet below ground surface

PCB - polychlorinated biphenyl

SPLP - Synthetic Precipitate Leaching Procedure

SVOC - semi-volatile organic compound

TCLP - Toxicity Characteristic Leaching Procedure

TPH - total petroleum hydrocarbons

unk - sample depth unknown

VOC - volatile organic compound

Analytical methods utilized are as follows:

Ammonia: Method E350.2 or E350.2M

Atterberg Limits: Method ASTM D4318

Chromium (VI): Method SW7196

Cyanide: Method SW9012 or SW9014

Grain Size: Method ASTM D422

Metals: Method SW6010, SW6020

Mercury: Method SW7470 or SW7471

Oil & Grease: Method E1668

PCBs: Method SW8082 or E1664

Percent Moisture: Method ASTM D2216, E160.3, or E160.3 Mod

Pesticides: Method SW8081

pH: Method SW9045

Phenolics: Method E420.2

Redox Potential: Method ASTM D1498

Porosity: Method API RP40

SVOCs: Method SW8270

Total Organic Carbon: Method SW9060, Walkley-Black, or SM5310

Total Solids: Method SM2540B

TPH: Method E418.1

VOCs: Method SW8260

TABLE 2-3

Monitoring Well Construction Summary  
 Quanta Resources Superfund Site, OU1  
 Edgewater, New Jersey

Well ID	Diameter/ Construction/ Slot Size	Northing	Easting	Measuring Point Elevation (TIC) (ft msl)	Ground Elevation (ft msl)	Property	Monitored Hydro- stratigraphic Unit	Top of Screen (ft bgs)	Top of Screen (ft msl)	Bottom of Screen (ft bgs)	Bottom of Screen (ft msl)	Screen Length (ft)
<b>Shallow Groundwater Wells</b>												
ACMW-1	4" PVC	719343.72	633428.46	11.29	12.1	Former Celotex	Unconfined	Unknown	Unknown	Unknown	Unknown	Unknown
ACMW-3	Unknown	719119.21	633543.67	14.34	14.7	Former Celotex	Unconfined	Unknown	Unknown	Unknown	Unknown	Unknown
DMW-2	Unknown	719172.49	633688.59	14.14	15.0	Former Celotex	Unconfined	Unknown	Unknown	Unknown	Unknown	Unknown
MW-101A	2" PVC	719022.06	632767.64	10.63	8.5	Block 93 North	Unconfined	4	4.5	19	-10.5	15
MW-102	2" PVC	718774.26	632941.80	9.24	6.4	Quanta	Unconfined	4	2.4	19	-12.6	15
MW-102A	4" PVC/20 slot	718774.51	632942.16	9.69	6.4	Quanta	Unconfined	2	4.4	12	-5.6	10
MW-102B	4" PVC/20 slot	718766.25	632931.53	9.61	6.4	Quanta	Unconfined	14	-7.6	24	-17.6	10
MW-103	2" PVC	718633.11	633224.04	8.57	6.4	Quanta	Unconfined	6	0.4	21	-14.6	15
MW-103A	4" PVC/20 slot	718607.48	633205.75	10.03	6.6	Quanta	Unconfined	3	3.6	13	-6.4	10
MW-104R	2" PVC/20 slot	718519.79	633611.94	9.11	6.2	Quanta	Unconfined	3	3.2	13	-6.8	10
MW-105	2" PVC	718420.92	633568.90	5.03	2.5	Quanta	Unconfined	9	-6.5	19	-16.5	10
MW-105A	4" PVC/20 slot	718414.17	633552.17	8.20	5.9	Quanta	Unconfined	3	2.9	13	-7.1	10
MW-106	2" PVC	718216.29	633448.63	7.13	7.4	Former Lever Brothers	Unconfined	11	-3.6	21	-13.6	10
MW-106A	4" PVC/20 slot	718187.85	633438.50	6.65	7.1	Former Lever Brothers	Unconfined	3	4.1	13	-5.9	10
MW-107	2" PVC	718396.33	633001.00	6.84	7.0	Former Lever Brothers	Unconfined	13	-6	23	-16	10
MW-107A	4" PVC/20 slot	718371.31	632973.74	7.04	7.5	Former Lever Brothers	Unconfined	3	4.5	13	-5.5	10
MW-108	2" PVC	718613.20	632760.11	7.17	7.7	115 River Road	Unconfined	7.5	0.2	12.5	-4.8	5
MW-109	2" PVC	718060.47	633348.35	4.49	4.8	Former Lever Brothers	Unconfined	15	-10.2	20	-15.2	5
MW-109A	4" PVC/20 slot	718064.11	633349.26	4.56	4.9	Former Lever Brothers	Unconfined	3	1.9	13	-8.1	10
MW-111A	4" PVC/20 slot	719195.22	632596.28	7.98	8.3	Block 93 North	Unconfined	2	6.3	9	-0.7	7
MW-111B	4" PVC/20 slot	719186.92	632597.85	7.85	8.4	Block 93 North	Unconfined	3	5.4	13	-4.6	10
MW-112A	4" PVC/20 slot	718954.83	633038.93	10.01	6.8	Quanta	Unconfined	3	3.8	10	-3.2	7
MW-112B	4" PVC/20 slot	718965.16	633046.35	9.60	6.8	Quanta	Unconfined	2	4.8	12	-5.2	10
MW-113A	4" PVC/20 slot	718887.05	633231.50	10.20	7.0	Quanta	Unconfined	3	4	13	-6	10
MW-113B	4" PVC/20 slot	718891.63	633233.93	9.94	7.0	Quanta	Unconfined	9	-2	19	-12	10
MW-113C	4" PVC/20 slot	718899.82	633232.35	9.80	7.2	Quanta	Unconfined	25	-17.8	30	-22.8	5
MW-114A	4" PVC/20 slot	718640.09	633028.45	7.41	7.8	115 River Road	Unconfined	3	4.8	13	-5.2	10
MW-114B	4" PVC/20 slot	718646.47	633018.97	7.24	7.6	115 River Road	Unconfined	15	-7.4	25	-17.4	10
MW-115A	4" PVC/20 slot	718206.33	632949.42	7.14	7.6	Former Lever Brothers	Unconfined	3	4.6	13	-5.4	10
MW-115B	4" PVC/20 slot	718209.64	632951.58	6.70	7.6	Former Lever Brothers	Unconfined	15.5	-7.9	25.5	-17.9	10
MW-116A	4" PVC/20 slot	718564.88	633607.66	9.45	6.1	Quanta	Unconfined	3	3.1	13	-6.9	10
MW-116B	4" PVC/20 slot	718564.00	633614.00	8.69	6.3	Quanta	Unconfined	3	3.3	13	-6.7	10
MW-117A	4" PVC/20 slot	718495.51	633575.22	9.37	6.8	Quanta	Unconfined	4	2.8	14	-7.2	10
MW-117B	4" PVC/20 slot	718490.38	633577.94	9.04	6.3	Quanta	Unconfined	5	1.3	15	-8.7	10
MW-118A	4" PVC/20 slot	718454.55	633573.47	9.00	6.1	Quanta	Unconfined	4	2.1	14	-7.9	10
MW-118B	4" PVC/20 slot	718443.68	633572.98	9.40	6.8	Quanta	Unconfined	4	2.8	14	-7.2	10
MW-119A	4" PVC/20 slot	718343.86	633523.03	6.00	6.4	115 River Road	Unconfined	3	3.4	13	-6.6	10
MW-119B	4" PVC/20 slot	718355.51	633526.26	5.68	6.2	115 River Road	Unconfined	4	2.2	14	-7.8	10
MW-120A	4" PVC/20 slot	718212.64	633495.32	6.83	7.1	Former Lever Brothers	Unconfined	3	4.1	13	-5.9	10
MW-120B	4" PVC/20 slot	718223.61	633484.97	6.78	7.2	Former Lever Brothers	Unconfined	7	0.2	17	-9.8	10
MW-121A	4" PVC/20 slot	718455.01	633276.03	7.13	7.5	115 River Road	Unconfined	3	4.5	13	-5.5	10
MW-121B	4" PVC/20 slot	718457.53	633272.15	7.16	7.6	115 River Road	Unconfined	12	-4.4	22	-14.4	10
MW-122A	4" PVC/20 slot	718339.41	632953.13	7.24	7.6	Former Lever Brothers	Unconfined	3	4.6	13	-5.4	10
MW-20	Unknown	718848.78	633445.86	15.05	15.5	Former Celotex	Unconfined	Unknown	Unknown	Unknown	Unknown	Unknown
MW-22A	Unknown	719250.48	633323.31	10.35	10.7	Former Celotex	Unconfined	Unknown	Unknown	Unknown	Unknown	Unknown

TABLE 2-3

Monitoring Well Construction Summary  
 Quanta Resources Superfund Site, OU1  
 Edgewater, New Jersey

Well ID	Diameter/ Construction/ Slot Size	Northing	Easting	Measuring Point Elevation (TIC) (ft msl)	Ground Elevation (ft msl)	Property	Monitored Hydro- stratigraphic Unit	Top of Screen (ft bgs)	Top of Screen (ft msl)	Bottom of Screen (ft bgs)	Bottom of Screen (ft msl)	Screen Length (ft)
MW-29	Unknown	718363.77	633048.64	7.09	7.4	Lever Brothers	Unconfined	Unknown	Unknown	Unknown	Unknown	Unknown
MW-31	Unknown	718314.63	632901.03	7.10	7.4	Lever Brothers	Unconfined	Unknown	Unknown	Unknown	Unknown	Unknown
MW-32	Unknown	718128.49	632889.70	6.30	6.5	Lever Brothers	Unconfined	Unknown	Unknown	Unknown	Unknown	Unknown
MW-36	Unknown	719610.43	634134.49	7.37	7.5	Lever Brothers	Unconfined	Unknown	Unknown	Unknown	Unknown	Unknown
MW-36EE	Unknown	719166.24	633686.59	Unknown	Unknown	Former Celotex	Unknown	Unknown	Unknown	Unknown	Unknown	Unknown
MW-4	Unknown	718125.74	632510.36	7.53	8.2	Lever Brothers	Unconfined	Unknown	Unknown	Unknown	Unknown	Unknown
MW-A-1	4" PVC	719111.78	633144.36	16.06	16.5	Former Celotex	Unconfined	24	-7.5	28	-11.5	4
MW-A-2	4" PVC	719104.51	633164.73	17.29	17.6	Former Celotex	Unconfined	6	11.6	16	1.6	10
MW-B	4" PVC	718860.98	633388.94	15.40	15.7	Former Celotex	Unconfined	9	6.7	19	-3.3	10
MW-C	4" PVC	718703.23	633651.85	14.75	15.2	Former Celotex	Unconfined	10	5.2	20	-4.8	10
MW-D	4" PVC	719033.11	633512.16	15.27	15.6	Former Celotex	Unconfined	7	8.6	12	3.6	5
MW-E	4" PVC	718829.23	633581.44	14.96	15.3	Former Celotex	Unconfined	9.28	6.02	19.28	-3.98	10
MW-F	4" PVC	718804.86	633811.88	11.29	11.8	Former Celotex	Unconfined	7	4.8	17	-5.2	10
MW-G	4" PVC	719310.72	633353.87	13.91	13.4	Former Celotex	Unconfined	3	10.4	13	0.4	10
MW-I	4" PVC	719078.28	633801.55	19.13	18.2	Former Celotex	Unconfined	9.5	8.7	19.5	-1.3	10
MW-J	4" PVC	718920.09	634110.90	16.09	16.5	Former Celotex	Unconfined	8	8.5	18	-1.5	10
MW-K	4" PVC	719274.51	633815.30	13.92	14.3	Former Celotex	Unconfined	5.9	8.4	15.9	-1.6	10
MW-L	4" PVC	719301.42	632947.29	15.05	15.5	Former Celotex	Unconfined	17	-1.5	27	-11.5	10
MW-N-1	4" PVC	719148.72	633040.28	12.00	12.5	Former Celotex	Unconfined	18.45	-5.95	23.45	-10.95	5
MW-N-2	Unknown	719157.71	633037.37	11.42	11.9	Former Celotex	Unconfined	5	6.9	10	1.9	5
MW-N-3	6-bedrock/open	719133.67	633089.76	13.34	13.8	Former Celotex	Bedrock	49.3	-35.5	59.3	-45.5	10
MW-O	4" PVC	718746.51	633563.10	15.51	15.7	Former Celotex	Unconfined	9.52	6.18	19.52	-3.82	10
TWP-SB28	1" PVC/10 slot	719191.85	632578.96	N/A	8.8	Block 93 North	Unconfined	8	0.8	9	-0.2	1
TWP-SB29	1" PVC/10 slot	719045.10	632565.07	N/A	6.3	Block 93 North	Unconfined	7.5	-1.2	8.5	-2.2	1
TWP-SB30	1" PVC/10 slot	719117.98	632612.12	N/A	7.8	Block 93 North	Unconfined	8	-0.2	9	-1.2	1
TWP-SB31	1" PVC/10 slot	718950.91	632638.30	N/A	5.4	Block 93 North	Unconfined	7.5	-2.1	8.5	-3.1	1
TWP-SB32	1" PVC/10 slot	719186.81	632715.50	N/A	8.6	Block 93 North	Unconfined	6.5	2.1	7.5	1.1	1
TWP-SB33	1" PVC/10 slot	719057.95	632743.82	N/A	7.7	Block 93 North	Unconfined	5	2.7	6	1.7	1
<b>Deep Sand Unit Wells</b>												
MW-101DS	6" steel outer casing, 2" PVC IC/20 slot	719004.98	632748.11	10.45	7.1	Block 93, Lot 3	Confined	38	-30.9	48	-40.9	10
MW-103DS	6" steel outer casing, 2" PVC IC/20 slot	718609.96	633208.63	10.13	6.5	Quanta	Confined	42	-35.5	52	-45.5	10
MW-107DS	6" steel outer casing, 2" PVC IC/20 slot	718369.21	632986.22	6.82	7.6	Lever Brothers	Confined	52	-44.4	62	-54.4	10
MW-116DS	6" steel outer casing, 2" PVC IC/20 slot	718555.99	633613.65	9.18	6.1	Quanta	Confined	19	-12.9	29	-22.9	10

## Notes:

ft msl - Feet above mean sea level, NAVD 88

ft bgs - Feet below ground surface

PVC - polyvinyl chloride

TIC - Top of monitoring well inner casing

**TABLE 2-4**

Summary of RI Groundwater and Surface Water Samples

*Quanta Resources Superfund Site, OU1**Edgewater, New Jersey*

		Parameter											
Location	Date	VOCs	SVOCs	Pesticides	PCBs	Ammonia	TKN	Arsenic (As) - total	Arsenic (As) - dissolved	As (III) and As (V)	Methylated Arsenic*	Iron (Fe)	Lead (Pb)
MW-102	11/15/05	X	X		X			X					X
MW-102B	11/15/05	X	X		X			X					X
MW-113A	11/15/05	X	X	X	X			X					X
MW-113B	11/15/05	X	X	X	X			X					X
MW-111A	11/16/05	X	X	X	X	X		X					X
MW-111B	11/16/05	X	X	X	X	X		X					X
MW-101A	11/17/05	X	X	X	X	X		X					X
MW-101DS	11/17/05	X	X		X			X					X
MW-103A	11/17/05	X	X	X	X			X					X
MW-103DS	11/17/05	X	X		X			X					X
SW-A	11/17/05	X	X	X	X	X		X					X
SW-B	11/17/05	X	X	X	X	X		X					X
SW-C	11/17/05	X	X	X	X	X		X					X
SW-D	11/17/05	X	X	X	X	X		X					X
MW-102A	11/18/05	X	X		X			X					X
MW-103	11/18/05	X	X	X	X			X					X
MW-112B	11/18/05	X	X	X	X	X		X					X
MW-105	11/21/05	X	X		X			X					X
MW-105A	11/21/05	X	X		X			X					X
MW-112A	11/21/05	X	X	X	X	X		X					X
MW-117A	11/21/05	X	X	X	X			X					X
MW-117B	11/21/05	X	X	X	X			X					X
MW-118A	11/21/05	X	X		X			X					X
MW-118B	11/21/05	X	X		X			X					X
MW-116A	11/22/05	X	X		X			X					X
MW-116B	11/22/05	X	X		X			X					X
MW-116DS	11/22/05	X	X		X			X					X
MW-107A	12/05/05	X	X		X			X					X
MW-120A	12/05/05	X	X		X			X					X
MW-120B	12/05/05	X	X		X			X					X
MW-122A	12/05/05	X	X		X			X					X
MW-106	12/06/05	X	X		X			X					X
MW-106A	12/06/05	X	X		X			X					X
MW-107	12/06/05	X	X		X			X					X
MW-109	12/06/05	X	X		X			X					X
MW-108	12/07/05	X	X		X			X					X
MW-119A	12/07/05	X	X		X			X					X
MW-119B	12/07/05	X	X		X			X					X
MW-107DS	12/30/05	X	X		X			X					X
MW-109A	12/30/05	X	X		X			X					X
MW-113C	12/30/05	X	X		X			X					X
MW-106	02/13/06	X	X		X			X					X
MW-106A	02/13/06	X	X		X			X					X
MW-120A	02/14/06	X	X		X			X					X
MW-120B	02/14/06	X	X		X			X					X
MW-109	02/15/06	X	X		X			X					X
MW-109A	02/15/06	X	X		X			X					X

**TABLE 2-4**

Summary of RI Groundwater and Surface Water Samples

*Quanta Resources Superfund Site, OU1**Edgewater, New Jersey*

Location	Date	Parameter											
		VOCs	SVOCs	Pesticides	PCBs	Ammonia	TKN	Arsenic (As) - total	Arsenic (As) - dissolved	As (III) and As (V)	Methylated Arsenic*	Iron (Fe)	Lead (Pb)
MW-107	02/16/06	X	X		X			X					X
MW-107A	02/16/06	X	X		X			X					X
MW-107DS	02/16/06	X	X		X			X					X
MW-111A	02/17/06	X	X	X	X	X		X					X
MW-111B	02/17/06	X	X	X	X	X		X					X
MW-103	02/20/06	X	X	X	X			X					X
MW-103A	02/20/06	X	X	X	X			X					X
MW-103DS	02/20/06	X	X		X			X					X
MW-113A	02/20/06	X	X	X	X			X					X
MW-113B	02/20/06	X	X	X	X			X					X
MW-113C	02/20/06	X	X		X			X					X
MW-101A	02/21/06	X	X	X	X	X		X					X
MW-101DS	02/21/06	X	X		X			X					X
MW-116A	02/21/06	X	X		X			X					X
MW-116DS	02/21/06	X	X		X			X					X
MW-117B	02/21/06	X	X	X	X			X					X
MW-112B	02/22/06	X	X	X	X	X		X					X
MW-116B	02/22/06	X	X		X			X					X
MW-117A	02/22/06	X	X	X	X			X					X
MW-118A	02/22/06	X	X		X			X					X
MW-118B	02/22/06	X	X		X			X					X
MW-102	02/23/06	X	X		X			X					X
MW-102B	02/23/06	X	X		X			X					X
MW-105	02/23/06	X	X		X			X					X
MW-105A	02/23/06	X	X		X			X					X
MW-112A	02/23/06	X	X	X	X	X		X					X
MW-115A	03/01/06	X	X		X			X					X
MW-115B	03/01/06	X	X		X			X					X
MW-114A	03/04/06	X	X		X			X					X
MW-114B	03/04/06	X	X		X			X					X
MW-119A	03/04/06	X	X		X			X					X
MW-119B	03/04/06	X	X		X			X					X
MW-121A	03/04/06	X	X		X			X					X
MW-121B	03/04/06	X	X		X			X					X
MW-B	03/13/06	X	X		X			X					X
MW-C	03/13/06	X	X		X			X					X
MW-F	03/13/06	X	X		X			X					X
MW-J	03/13/06	X	X		X			X					X
MW-A-1	03/14/06	X	X		X			X					X
MW-A-2	03/14/06	X	X		X	X		X					X
MW-G	03/14/06	X	X		X			X					X
MW-I	03/14/06	X	X		X			X					X
MW-L	03/15/06	X	X		X	X		X					X
MW-120A	05/15/06	X	X		X			X					X
MW-120B	05/15/06	X	X		X			X					X
MW-106	05/16/06	X	X		X			X					X
MW-106A	05/16/06	X	X		X			X					X

**TABLE 2-4**

Summary of RI Groundwater and Surface Water Samples

*Quanta Resources Superfund Site, OU1**Edgewater, New Jersey*

		Parameter											
Location	Date	VOCs	SVOCs	Pesticides	PCBs	Ammonia	TKN	Arsenic (As) - total	Arsenic (As) - dissolved	As (III) and As (V)	Methylated Arsenic*	Iron (Fe)	Lead (Pb)
MW-107A	05/16/06	X	X		X			X					X
MW-107DS	05/16/06	X	X		X			X					X
MW-109A	05/16/06	X	X		X			X					X
MW-115A	05/16/06	X	X		X			X					X
MW-115B	05/16/06	X	X		X			X					X
MW-108	05/17/06	X	X		X			X					X
MW-109	05/17/06	X	X		X			X					X
MW-113A	05/17/06	X	X	X	X			X					X
MW-113B	05/17/06	X	X	X	X			X					X
MW-113C	05/17/06	X	X	X	X			X					X
MW-122A	05/17/06	X	X		X			X					X
MW-101A	05/18/06	X	X	X	X	X		X					X
MW-111A	05/18/06	X	X	X	X	X		X					X
MW-111B	05/18/06	X	X	X	X	X		X					X
MW-101DS	05/19/06	X	X		X			X					X
MW-103A	05/19/06	X	X	X	X			X					X
MW-103DS	05/19/06	X	X		X			X					X
MW-114A	05/20/06	X	X		X			X					X
MW-114B	05/20/06	X	X		X			X					X
MW-119A	05/20/06	X	X		X			X					X
MW-119B	05/20/06	X	X		X			X					X
MW-121A	05/20/06	X	X		X			X					X
MW-101A	05/18/06	X	X	X	X	X		X					X
MW-105A	05/22/06	X	X		X			X					X
MW-116DS	05/22/06	X	X		X			X					X
MW-117B	05/22/06	X	X	X	X			X					X
MW-118A	05/22/06	X	X		X			X					X
MW-C	05/22/06	X	X		X			X					X
MW-F	05/22/06	X	X		X			X					X
MW-A-1	05/23/06	X	X		X			X					X
MW-A-2	05/23/06	X	X		X	X		X					X
MW-B	05/23/06	X	X		X			X					X
MW-G	05/23/06	X	X		X			X					X
MW-I	05/23/06	X	X		X			X					X
MW-J	05/23/06	X	X		X			X					X
MW-L	05/24/06	X	X		X	X		X					X
MW-106	08/15/06	X	X		X			X					X
MW-115A	08/15/06	X	X		X			X					X
MW-115B	08/15/06	X	X		X			X					X
MW-120A	08/15/06	X	X		X			X					X
MW-120B	08/15/06	X	X		X			X					X
MW-106A	08/16/06	X	X		X			X					X
MW-29	08/16/06	X	X		X			X					X
MW-31	08/16/06	X	X		X			X					X
MW-107A	08/17/06	X	X		X			X		X			X
MW-109	08/17/06	X	X		X			X					X
MW-109A	08/17/06	X	X		X			X		X			X



**TABLE 2-4**

Summary of RI Groundwater and Surface Water Samples

*Quanta Resources Superfund Site, OU1**Edgewater, New Jersey*

Location	Date	Parameter											
		VOCs	SVOCs	Pesticides	PCBs	Ammonia	TKN	Arsenic (As) - total	Arsenic (As) - dissolved	As (III) and As (V)	Methylated Arsenic*	Iron (Fe)	Lead (Pb)
MW-32	08/17/06	X	X		X			X					X
MW-36EE	08/17/06	X	X		X			X		X			X
MW-107DS	08/18/06	X	X		X			X					X
MW-108	08/18/06	X	X		X			X					X
MW-122A	08/18/06	X	X		X			X					X
MW-4	08/18/06	X	X		X			X					X
MW-114A	08/19/06	X	X		X			X					X
MW-119B	08/19/06	X	X		X			X					X
MW-121A	08/19/06	X	X		X			X					X
MW-101A	08/21/06	X	X	X	X	X		X					X
MW-101DS	08/21/06	X	X		X			X					X
MW-111A	08/21/06	X	X	X	X	X		X					X
MW-113A	08/21/06	X	X	X	X			X					X
MW-113C	08/21/06	X	X		X			X					X
MW-103A	08/22/06	X	X	X	X			X					X
MW-103DS	08/22/06	X	X		X			X					X
MW-111B	08/22/06	X	X	X	X	X		X		X			X
MW-113B	08/22/06	X	X	X	X			X		X			X
MW-116DS	08/22/06	X	X		X			X					X
MW-117B	08/23/06	X	X	X	X			X					X
MW-118A	08/23/06	X	X		X			X					X
MW-A-1	08/23/06	X	X		X			X					X
MW-G	08/23/06	X	X		X			X					X
MW-I	08/23/06	X	X		X			X					X
MW-J	08/23/06	X	X		X			X					X
MW-A-2	08/24/06	X	X		X	X		X		X			X
MW-B	08/24/06	X	X		X			X		X			X
MW-C	08/24/06	X	X		X			X		X			X
MW-F	08/24/06	X	X		X			X		X			X
MW-L	08/24/06	X	X		X	X		X		X			X
MW-114B	08/26/06	X	X		X			X		X			X
DMW-2	10/23/06							X					
MW-36EE	10/23/06							X					
MW-113B	10/24/06					X	X	X			X	X	
MW-B	10/24/06					X	X	X			X	X	
MW-C	10/24/06					X	X	X			X	X	
MW-F	10/24/06					X	X	X			X	X	
MW-A-2	10/25/06					X	X	X			X	X	
MW-E	10/25/06							X					
MW-N-1	10/25/06					X	X	X		X	X	X	
MW-N-2	10/25/06					X	X	X		X	X	X	
MW-O	10/25/06					X	X	X		X	X	X	
ACMW-1	10/26/06							X					
MW-107A	10/26/06					X	X	X			X	X	
MW-109A	10/26/06					X	X	X			X	X	
MW-111B	10/26/06					X	X	X			X	X	
MW-114B	10/26/06					X	X	X			X	X	

**TABLE 2-4**

Summary of RI Groundwater and Surface Water Samples

*Quanta Resources Superfund Site, OU1**Edgewater, New Jersey*

		Parameter											
Location	Date	VOCs	SVOCs	Pesticides	PCBs	Ammonia	TKN	Arsenic (As) - total	Arsenic (As) - dissolved	As (III) and As (V)	Methylated Arsenic*	Iron (Fe)	Lead (Pb)
MW-20	10/26/06							X					
MW-36EE	10/26/06					X	X	X			X	X	
MW-H	10/26/06							X					
MW-L	10/26/06					X	X	X			X	X	
MW-M	10/26/06							X					
MW-N-3	10/26/06							X					
ACMW-3	10/27/06							X					
MW-22A	10/27/06							X					
MW-K	10/27/06							X					
TWP-SB28	06/05/07	X	X					X	X				
TWP-SB29	06/06/07	X	X					X	X				
TWP-SB30	06/05/07	X	X					X	X				
TWP-SB31	06/06/07	X	X					X	X				
TWP-SB32	06/06/07	X	X					X	X				
TWP-SB33	06/04/07	X	X										

## Notes:

\* The methylated arsenic species include monomethylarsonic acid [MMA(V)], monomethylarsonous acid [MMA(III)], dimethylarsinic acid [DMA(V)], dimethylarsinous acid [DMA(III)], and trimethylarsenic oxide [TMAO(V)].

VOC - volatile organic compound

SVOC - semivolatile organic compound

PCB - polychlorinated biphenyl

TKN - total Kjeldahl nitrogen

Analytical methods utilized are as follows:

VOCs: Method 624 or SW8260

SVOCs: Method SW8270

Pesticides: Method 608 or SW8081

PCBs: Method SW8082

Ammonia: Method 350.2M, E350.1, or E350.2

Cyanide: Method 9014

TKN: Method E351.2

Arsenic Speciation: Method SW7063

Methylated Arsenic Species: Method SW6800

Metals: Method SW6010, SW6120, or 200.7

Mercury: Method 7471A

TABLE 2-5

Summary of Groundwater and Standing Water Quality Field Parameter Results

Quanta Resources Superfund Site, OU1

Edgewater, New Jersey

Sample Location	Property	Sampling Event	pH	Temp. (° C)	Cond. (mS/cm)	ORP (mV)	DO (mg/L)	Turbidity (NTU)	Comments
MW-4	Former Lever Brothers	1	NS	NS	NS	NS	NS	NS	Not in sampling plan
		2	NS	NS	NS	NS	NS	NS	Not in sampling plan
		3	NS	NS	NS	NS	NS	NS	Not in sampling plan
		4	6.29	20.32	4.10	-344.5	*	1.8	Yellow, sulfur odor
		5	NS	NS	NS	NS	NS	NS	Not in sampling plan
MW-20	Former Lever Brothers	1	NS	NS	NS	NS	NS	NS	Not in sampling plan
		2	NS	NS	NS	NS	NS	NS	Not in sampling plan
		3	NS	NS	NS	NS	NS	NS	Not in sampling plan
		4	NS	NS	NS	NS	NS	NS	Not in sampling plan
		5	6.98	18.68	1.462	-99.3	*	55.0	Clear, no odor
MW-22A	Former Lever Brothers	1	NS	NS	NS	NS	NS	NS	Not in sampling plan
		2	NS	NS	NS	NS	NS	NS	Not in sampling plan
		3	NS	NS	NS	NS	NS	NS	Not in sampling plan
		4	NS	NS	NS	NS	NS	NS	Not in sampling plan
		5	4.25	15.78	2.820	196.0	2.14	1.5	Clear, no odor
MW-29	Former Lever Brothers	1	NS	NS	NS	NS	NS	NS	Not in sampling plan
		2	NS	NS	NS	NS	NS	NS	Not in sampling plan
		3	NS	NS	NS	NS	NS	NS	Not in sampling plan
		4	6.06	17.95	2.70	-111	*	7.9	Dark grey, sulfur odor
		5	NS	NS	NS	NS	NS	NS	Not in sampling plan
MW-31	Former Lever Brothers	1	NS	NS	NS	NS	NS	NS	Not in sampling plan
		2	NS	NS	NS	NS	NS	NS	Not in sampling plan
		3	NS	NS	NS	NS	NS	NS	Not in sampling plan
		4	6.16	22.64	2.21	108	*	1.5	Yellow, slight product odor
		5	NS	NS	NS	NS	NS	NS	Not in sampling plan
MW-32	Former Lever Brothers	1	NS	NS	NS	NS	NS	NS	Not in sampling plan
		2	NS	NS	NS	NS	NS	NS	Not in sampling plan
		3	NS	NS	NS	NS	NS	NS	Not in sampling plan
		4	6.91	27.40	5.98	-324	0.69	3.2	Blackish grey, slight product odor
		5	NS	NS	NS	NS	NS	NS	Not in sampling plan
MW-36	Former Lever Brothers	1	NS	NS	NS	NS	NS	NS	Not in sampling plan
		2	NS	NS	NS	NS	NS	NS	Not in sampling plan
		3	NS	NS	NS	NS	NS	NS	Not in sampling plan
		4	7.06	21.12	3.74	-354	*	2.0	Clear, sulfur odor
		5	7.03	18.31	6.717	-374.6	*	6.5	Cloudy, strong organic odor
MW-36EE	Former Celotex	1	NS	NS	NS	NS	NS	NS	Not in sampling plan
		2	NS	NS	NS	NS	NS	NS	Not in sampling plan
		3	NS	NS	NS	NS	NS	NS	Not in sampling plan
		4	NS	NS	NS	NS	NS	NS	Not in sampling plan
		5	6.75	16.91	17.48	-131.0	1.63	23.1	Clear, no odor
MW-101A	Block 93 North	1	6.89	16.00	2.03	-140	0.00	17.0	Reddish brown
		2	7.08	12.20	1.66	-128	1.83	41.0	Clear, no odor
		3	6.97	14.40	1.36	-142	0.00	5.9	Clear, musty odor
		4	8.22	16.26	1.84	-130	*	16.1	Clear, no odor
		5	NS	NS	NS	NS	NS	NS	Not in sampling plan
MW-101DS	Block 93 North	1	7.08	15.36	1.26	38	1.63	1.9	Clear, no odor
		2	7.34	12.94	1.16	57	3.92	3.4	Clear, no odor
		3	7.31	14.30	1.28	6	3.11	14.0	Clear, no odor
		4	4.62	16.37	15.40	*	0.86	5.6	Clear, no odor
		5	NS	NS	NS	NS	NS	NS	Not in sampling plan
MW-102	Quanta	1	6.98	18.14	2.50	-302	0.00	10	Clear, product odor
		2	6.25	13.47	2.27	-338	*	3.2	Dark grey, sulfur odor
		3	NS	NS	NS	NS	NS	NS	NAPL present
		4	NS	NS	NS	NS	NS	NS	NAPL present
		5	NS	NS	NS	NS	NS	NS	Not in sampling plan

TABLE 2-5

Summary of Groundwater and Standing Water Quality Field Parameter Results

Quanta Resources Superfund Site, OU1

Edgewater, New Jersey

Sample Location	Property	Sampling Event	pH	Temp. (° C)	Cond. (mS/cm)	ORP (mV)	DO (mg/L)	Turbidity (NTU)	Comments
MW-102A	Quanta	1	8.10	15.06	1.45	-321	0.00	4.65	Light tan, product odor
		2	NS	NS	NS	NS	NS	NS	NAPL present
		3	NS	NS	NS	NS	NS	NS	NAPL present
		4	NS	NS	NS	NS	NS	NS	NAPL present
		5	NS	NS	NS	NS	NS	NS	Not in sampling plan
MW-102B	Quanta	1	6.25	16.75	5.11	-268	0.45	19.0	Clear, product odor
		2	6.47	13.70	5.44	-141	2.60	14.9	Clear, product odor
		3	NS	NS	NS	NS	NS	NS	NAPL present
		4	NS	NS	NS	NS	NS	NS	NAPL present
		5	NS	NS	NS	NS	NS	NS	Not in sampling plan
MW-103	Quanta	1	6.32	15.90	1.87	-365	0.00	9.2	Clear, product odor
		2	5.83	11.94	1.92	-43	0.72	23.0	Cloudy grey, strong product odor
		3	NS	NS	NS	NS	NS	NS	NAPL present
		4	NS	NS	NS	NS	NS	NS	NAPL present
		5	NS	NS	NS	NS	NS	NS	Not in sampling plan
MW-103A	Quanta	1	6.95	14.14	1.04	-314	0.00	1.8	Grey, product odor
		2	7.33	5.40	0.690	-216	*	1.7	Clear, product odor
		3	7.35	11.70	0.783	-267	2.35	3.7	Clear, strong product odor
		4	5.81	18.91	0.624	-304	1.18	1.3	Clear, strong product odor
		5	NS	NS	NS	NS	NS	NS	Not in sampling plan
MW-103DS	Quanta	1	7.51	14.22	1.07	-37	0.12	5.7	Clear, no odor
		2	7.86	12.20	1.11	-27	1.71	4.6	Clear, no odor
		3	7.59	13.10	0.979	47	0.00	8.0	Clear, no odor
		4	6.32	15.96	0.697	*	0.97	1.0	Clear, no odor
		5	NS	NS	NS	NS	NS	NS	Not in sampling plan
MW-105	Quanta	1	6.47	18.21	0.676	-263	0.26	3.4	Grey, strong product odor
		2	7.28	9.20	0.900	-67	*		
		3	NS	NS	NS	NS	NS	NS	NAPL present
		4	NS	NS	NS	NS	NS	NS	NAPL present
		5	NS	NS	NS	NS	NS	NS	Not in sampling plan
MW-105A	Quanta	1	6.65	17.83	1.26	-281	0.00	1.50	Clear, strong product odor
		2	6.29	6.84	0.64	-269	*	3.20	Clear, product odor
		3	7.23	16.83	0.686	-253	1.99	0.00	Clear, strong product odor
		4	NS	NS	NS	NS	NS	NS	NAPL present
		5	NS	NS	NS	NS	NS	NS	Not in sampling plan
MW-106	Former Lever Brothers	1	6.86	18.45	3.86	-163	0.00	6	Cloudy black, product odor
		2	6.89	11.40	3.03	-74	1.74	3.8	Clear, sulfur odor
		3	7.22	12.17	9.70	-344	1.00	13.4	Blackish grey, strong product odor
		4	6.85	15.97	5.25	-320	*	2.43	Grey, strong product odor
		5	NS	NS	NS	NS	NS	NS	Not in sampling plan
MW-106A	Former Lever Brothers	1	6.48	18.13	2.65	-132	0.00	3	Grey, sulfur odor
		2	6.22	12.50	2.19	-125	2.75	4.4	Clear
		3	6.60	12.20	2.17	-140	*	130.0	High turbidity
		4	4.89	15.53	2.05	-31	1.94	1.40	Grey, slight product odor
		5	NS	NS	NS	NS	NS	NS	Not in sampling plan
MW-107	Former Lever Brothers	1	4.10	17.34	3.60	146	0.00	3	Clear, no odor
		2	4.29	14.87	3.89	117	0.51	9.4	Grey, strong product odor
		3	NS	NS	NS	NS	NS	NS	NAPL present
		4	NS	NS	NS	NS	NS	NS	NAPL present
		5	NS	NS	NS	NS	NS	NS	Not in sampling plan
MW-107A	Former Lever Brothers	1	7.14	16.91	4.44	79	0.00	*	Clear, product odor
		2	4.34	15.46	4.74	112	0.47	1	Clear, strong product odor
		3	4.28	13.83	4.22	140	3.38	0	Clear, no odor
		4	3.60	16.96	3.51	218	8.37	1.56	Clear, product odor
		5	4.00	16.37	*	114.3	*	1.73	Clear, no odor

TABLE 2-5

Summary of Groundwater and Standing Water Quality Field Parameter Results

Quanta Resources Superfund Site, OU1

Edgewater, New Jersey

Sample Location	Property	Sampling Event	pH	Temp. (° C)	Cond. (mS/cm)	ORP (mV)	DO (mg/L)	Turbidity (NTU)	Comments
MW-107DS	Former Lever Brothers	1	9.00	13.30	1.10	-48	0.00	320	Cloudy brown, no odor
		2	8.46	14.60	0.898	14	2.07	Over Range	Very turbid, silt/clay
		3	8.28	14.80	0.841	19	1.45	110	Grey/brown, cloudy
		4	7.98	16.27	0.67	99	4.99	377	Light brown, no odor
		5	NS	NS	NS	NS	NS	NS	Not in sampling plan
MW-108	115 River Road	1	6.71	20.23	3.73	-147	0.00	22	Clear, product odor
		2	NS	NS	NS	NS	NS	NS	Blocked by broken excavator
		3	7.03	15.00	4.18	-149	0.31	13	Blackish grey, cloudy
		4	6.24	21.62	3.13	-127	*	20.6	Grey, no odor
		5	NS	NS	NS	NS	NS	NS	Not in sampling plan
MW-109	Former Lever Brothers	1	6.33	15.52	19.70	-90	6.64	23	Grey, product odor
		2	6.49	12.43	17.10	-135	2.75	60	Black, strong product odor
		3	7.00	12.53	18.80	-193	1.16		Clear, sulfur odor
		4	4.84	19.09	15.39	-97	0.60	28	Grey, murky, brown froth, tiny white worms
		5	NS	NS	NS	NS	NS	NS	Not in sampling plan
MW-109A	Former Lever Brothers	1	7.43	9.60	3.78	-19	2.64	2	Clear, no odor
		2	7.36	8.00	9.35	-128	4.14	12	
		3	6.97	14.40	3.02	50	1.88	21	Clear, no odor
		4	7.07	22.50	10.09	-213	*	2	Tiny white worms
		5	6.90	19.03	1.399	-180.4	0.32	11	Grey, product odor
MW-111A	Block 93 North	1	6.68	19.51	3.67	-195	0.73	0.80	Light yellow, product odor
		2	6.72	8.40	2.42	-147	1.48	9.20	
		3	6.72	18.40	2.58	-127	*	1.60	Clear, no odor
		4	6.40	28.20	2.64	-139	0.52	1.00	Slight orange froth, slight product odor
		5	NS	NS	NS	NS	NS	NS	Not in sampling plan
MW-111B	Block 93 North	1	6.40	21.10	3.31	-155	0.00	1.59	Light yellow, product odor
		2	6.61	10.15	2.71	-119	1.17	13.00	
		3	6.69	18.00	2.71	-179	0.00	6.40	Brownish color
		4	6.82	27.67	3.21	-131	*	6.54	Clear, slight sheen
		5	6.67	20.17	3.454	-184.8	3.31	3.49	Clear, no odor
MW-112A	Quanta	1	10.56	17.97	3.67	-459	0.00	18.00	Yellow brown, product odor
		2	9.96	7.10	1.91	-130	*	*	
		3	NS	NS	NS	NS	NS	NS	NAPL present
		4	NS	NS	NS	NS	NS	NS	NAPL present
		5	NS	NS	NS	NS	NS	NS	Not in sampling plan
MW-112B	Quanta	1	6.22	19.47	6.16	-354	0.01	1.60	Greenish color, product odor
		2	6.25	9.59	4.58	-83	5.15	9.30	Clear, product odor
		3	NS	NS	NS	NS	NS	NS	NAPL present
		4	NS	NS	NS	NS	NS	NS	NAPL present
		5	NS	NS	NS	NS	NS	NS	Not in sampling plan
MW-113A	Quanta	1	6.51	18.38	3.38	-114	0.00	3.13	Light yellow, sulfur and petroleum odor
		2	6.79	8.00	3.29	-113	1.94	5.30	Clear, product odor
		3	6.70	16.20	3.11	-74	3.70	10.80	Clear, no odor
		4	2.63	22.15	85.30	*	0.53	4.24	Clear, no odor
		5	NS	NS	NS	NS	NS	NS	Not in sampling plan
MW-113B	Quanta	1	4.64	18.84	3.39	156	0.00	12.1	Yellow, cloudy
		2	5.36	11.62	3.33	96	4.56	17.0	Clear, no odor
		3	4.92	13.80	3.26	115	1.74	280.0	Cloudy white
		4	1.78	18.06	2.23	*	1.03	11.2	Clear, no odor
		5	4.60	16.92	2.381	185.3	6.23	62.4	Clear, no odor

TABLE 2-5

Summary of Groundwater and Standing Water Quality Field Parameter Results

Quanta Resources Superfund Site, OU1

Edgewater, New Jersey

Sample Location	Property	Sampling Event	pH	Temp. (° C)	Cond. (mS/cm)	ORP (mV)	DO (mg/L)	Turbidity (NTU)	Comments
MW-113C	Quanta	1	4.22	13.60	3.64	180	0.00	7.1	Clear, no odor
		2	3.99	13.70	3.40	300	2.75	11.0	Clear
		3	3.77	14.40	3.17	238	0.35	0.0	Clear
		4	4.94	16.47	2.30	132	*	4.9	Clear, no odor
		5	NS	NS	NS	NS	NS	NS	Not in sampling plan
MW-114A	115 River Road	1	NS	NS	NS	NS	NS	NS	Not yet installed
		2	5.54	8.71	2.14	-109	*	8.4	Brownish, product odor
		3	6.94	14.94	0.909	-184	0.00	1.5	Clear, no odor
		4	6.36	23.84	1.10	-90	*	2.0	
		5	NS	NS	NS	NS	NS	NS	Not in sampling plan
MW-114B	115 River Road	1	NS	NS	NS	NS	NS	NS	Not yet installed
		2	6.13	13.14	4.09	-35	3.99	15.7	Clear
		3	6.06	14.70	3.68	-93	0.46	3.3	Clear, product odor
		4	6.38	16.87	1.03	-40	*	6.5	Clear, no odor
		5	7.30	15.29	55.891	-49.7	0.00	49.1	Clear, organic odor
MW-115A	Former Lever Brothers	1	NS	NS	NS	NS	NS	NS	Not yet installed
		2	5.65	8.35	2.40	-98	7.68	50.0	Clear, no odor
		3	7.08	11.93	2.04	-85	6.32	29.0	Clear
		4	5.73	20.65	1.86	-81	4.26	1.9	Tiny worms on surface, clear, slight sulfur odor
		5	NS	NS	NS	NS	NS	NS	Not in sampling plan
MW-115B	Former Lever Brothers	1	NS	NS	NS	NS	NS	NS	Not yet installed
		2	4.88	9.94	29.90	-65	4.72	72.1	Clear, no odor
		3	6.28	13.24	13.06	-134	1.24	28.0	Grey, no odor
		4	5.54	16.06	20.70	-90	6.83	17.7	Clear, no odor
		5	NS	NS	NS	NS	NS	NS	Not in sampling plan
MW-116A	Quanta	1	6.73	16.92	0.49	-377	0.34	3.7	
		2	7.34	10.64	0.671	-104	*	7.6	Grey, strong product odor
		3	NS	NS	NS	NS	NS	NS	NAPL present
		4	NS	NS	NS	NS	NS	NS	NAPL present
		5	NS	NS	NS	NS	NS	NS	Not in sampling plan
MW-116B	Quanta	1	6.82	14.79	1.06	-179	1.48	15.0	Grey, product odor
		2	6.78	8.14	1.06	-94	*	4.9	Clear, product odor
		3	NS	NS	NS	NS	NS	NS	NAPL present
		4	NS	NS	NS	NS	NS	NS	NAPL present
		5	NS	NS	NS	NS	NS	NS	Not in sampling plan
MW-116DS	Quanta	1	7.32	15.22	1.85	-391	0.00	8.2	Cloudy grey, no odor
		2	7.42	13.50	1.87	-42	1.62	2.0	Clear
		3	7.78	13.94	1.78	-87	*	0.0	Clear, no odor
		4	7.33	16.59	1.54	27	*	1.8	Grey, no odor
		5	NS	NS	NS	NS	NS	NS	Not in sampling plan
MW-117A	Quanta	1	6.51	16.77	0.43	-204	0.04	0.7	Clear, product odor
		2	6.87	6.60	0.458	-77	1.81	1.1	Clear, strong product odor
		3	NS	NS	NS	NS	NS	NS	NAPL present
		4	NS	NS	NS	NS	NS	NS	NAPL present
		5	NS	NS	NS	NS	NS	NS	Not in sampling plan
MW-117B	Quanta	1	6.69	17.02	0.55	-160	0.30	2.63	Clear, strong product odor
		2	7.38	9.82	0.554	-158	*	2.60	Clear, no odor
		3	7.21	13.40	0.662	-196	0.00	3.30	Clear, product odor
		4	6.25	19.70	0.483	-142	0.36	1.11	Clear, slight product odor
		5	NS	NS	NS	NS	NS	NS	Not in sampling plan
MW-118A	Quanta	1	6.61	17.07	1.19	-206	0.48	0.00	Clear, slight product odor
		2	6.79	6.90	0.571	-88	1.83	0.70	Clear
		3	6.92	14.80	0.530	-96	0.37	0.87	Clear, no odor
		4	6.43	24.20	0.680	-74	*	0.07	Clear, product odor
		5	NS	NS	NS	NS	NS	NS	Not in sampling plan

TABLE 2-5

Summary of Groundwater and Standing Water Quality Field Parameter Results

Quanta Resources Superfund Site, OU1

Edgewater, New Jersey

Sample Location	Property	Sampling Event	pH	Temp. (° C)	Cond. (mS/cm)	ORP (mV)	DO (mg/L)	Turbidity (NTU)	Comments
MW-118B	Quanta	1	6.47	17.87	0.59	-133	0.26	0.94	Clear, product odor
		2	6.94	9.10	0.560	-72	*	4.80	Clear
		3	NS	NS	NS	NS	NS	NS	NAPL present
		4	NS	NS	NS	NS	NS	NS	NAPL present
		5	NS	NS	NS	NS	NS	NS	Not in sampling plan
MW-119A	115 River Road	1	6.47	17.80	4.06	-139	0.00	-2.01	Clear
		2	5.65	10.67	5.42	-88	*	10.90	Clear
		3	6.57	15.60	6.87	-103	0.02	15.00	Clear, no odor
		4	NS	NS	NS	NS	NS	NS	NAPL present
		5	NS	NS	NS	NS	NS	NS	Not in sampling plan
MW-119B	115 River Road	1	6.95	18.75	5.50	-277	0.00	2.98	Clear, no odor
		2	7.18	12.00	6.42	-240	1.01	11.90	Clear
		3	7.12	15.20	11.70	-146	2.48	13.00	Clear, no odor
		4	6.68	21.26	8.00	-163	*	4.25	Clear
		5	NS	NS	NS	NS	NS	NS	Not in sampling plan
MW-120A	Former Lever Brothers	1	11.15	17.85	4.33	-134	0.00	*	Clear, strong sulfur odor
		2	6.16	11.84	7.57	-37	0.46	1.90	Clear
		3	6.63	12.20	6.15	-111	0.00	11.00	Clear, no odor
		4	6.52	18.25	5.29	-273	*	0.00	Clear, no odor
		5	NS	NS	NS	NS	NS	NS	Not in sampling plan
MW-120B	Former Lever Brothers	1	6.93	18.17	18.90	-333	0.00	*	Grey, sulfur odor
		2	7.08	14.10	8.65	-314	2.04	2.50	Clear, sulfur odor
		3	7.08	12.00	12.60	-348	0.33	6.30	Black/grey, sulfur odor
		4	6.16	15.02	0.01	-341	0.75	0.00	Dark grey, sulfur odor
		5	NS	NS	NS	NS	NS	NS	Not in sampling plan
MW-121A	115 River Road	1	NS	NS	NS	NS	NS	NS	Not yet installed
		2	5.91	10.80	1.08	-101	*	9.29	Clear
		3	7.74	14.00	0.29	-40	0.98	19.00	Clear, no odor
		4	6.66	19.47	0.20	-16	0.35	5.50	Clear, no odor
		5	NS	NS	NS	NS	NS	NS	Not in sampling plan
MW-121B	115 River Road	1	NS	NS	NS	NS	NS	NS	Not yet installed
		2	7.49	11.96	1.85	-152	1.20	26.70	Clear
		3	NS	NS	NS	NS	NS	NS	NAPL present
		4	NS	NS	NS	NS	NS	NS	NAPL present
		5	NS	NS	NS	NS	NS	NS	Not in sampling plan
MW-122A	Former Lever Brothers	1	5.01	16.10	3.61	33	0.00	*	Clear, product odor
		2	NS	NS	NS	NS	NS	NS	Not in sampling plan
		3	4.84	13.20	3.73	90	0.00	1.5	Clear, gasoline odor
		4	4.78	18.09	2.40	133	0.35	3.4	Froth, product odor
		5	NS	NS	NS	NS	NS	NS	Not in sampling plan
MW-A1	Former Celotex	1	NS	NS	NS	NS	NS	NS	Unable to access well
		2	5.41	15.21	2.97	-42	0.84	8.70	Clear, no odor
		3	5.04	15.00	3.32	100	0.41	8.80	Clear, no odor
		4	2.00	17.71	1.75	*	1.13	10.16	Tan, slight product odor
		5	NS	NS	NS	NS	NS	NS	Not in sampling plan
MW-A2	Former Celotex	1	NS	NS	NS	NS	NS	NS	Unable to access well
		2	5.72	14.00	4.01	26	0.00	14.00	Clear, no odor
		3	5.73	14.60	4.11	-43	0.00	4.57	Clear, no odor
		4	4.60	19.08	2.87	*	0.90	16.80	Clear, no odor
		5	5.92	19.09		-60.0	0.00	114.00	Clear, product odor
MW-B	Former Celotex	1	NS	NS	NS	NS	NS	NS	Unable to access well
		2	5.78	13.90	3.87	75	0.00	10.00	Clear, no odor
		3	6.12	15.17	3.33	53	3.49	17.00	Tan, no odor
		4	4.58	18.40	2.02	*	0.90	7.91	
		5	3.58	18.54	4.321	182.2	*	9.66	Clear, no odor

TABLE 2-5

Summary of Groundwater and Standing Water Quality Field Parameter Results

Quanta Resources Superfund Site, OU1

Edgewater, New Jersey

Sample Location	Property	Sampling Event	pH	Temp. (° C)	Cond. (mS/cm)	ORP (mV)	DO (mg/L)	Turbidity (NTU)	Comments
MW-C	Former Celotex	1	NS	NS	NS	NS	NS	NS	Unable to access well
		2	7.09	13.32	6.16	-252	0.00	3.50	Grey, strong product odor
		3	6.89	15.18	4.67	-148	3.34	0.00	Clear, product odor
		4	6.36	19.05	3.47	-202	*	15.30	Grey, black floaties, strong product odor
		5	6.18	19.18	4.619	-134.9	*	11.90	Grey, product odor
MW-D	Former Celotex	1	NS	NS	NS	NS	NS	NS	Unable to access well
		2	NS	NS	NS	NS	NS	NS	Well was dry
		3	NS	NS	NS	NS	NS	NS	Well was dry
		4	NS	NS	NS	NS	NS	NS	Well was dry
		5	NS	NS	NS	NS	NS	NS	Not in sampling plan
MW-E	Former Celotex	1	NS	NS	NS	NS	NS	NS	Not in sampling plan
		2	NS	NS	NS	NS	NS	NS	Not in sampling plan
		3	NS	NS	NS	NS	NS	NS	Not in sampling plan
		4	NS	NS	NS	NS	NS	NS	Not in sampling plan
		5	6.91	18.89	1.803	-160.1	*	13.9	Clear, moderate product odor
MW-F	Former Celotex	1	NS	NS	NS	NS	NS	NS	Unable to access well
		2	7.40	14.16	3.51	-148	0.00	12.00	Clear, no odor
		3	7.05	15.10	3.38	-136	0.00	4.72	Clear, no odor
		4	5.94	18.60	1.81	*	0.68	5.39	Clear, no odor
		5	7.02	16.96	2.770	-166.8	1.66	12.90	Slightly cloudy, no odor
MW-G	Former Celotex	1	NS	NS	NS	NS	NS	NS	Unable to access well
		2	6.94	11.40	3.76	10	0.00	6.30	Clear, no odor
		3	7.31	14.10	3.25	-65	3.23	0.00	Clear, no odor
		4	6.02	19.71	2.089	*	0.80	4.93	Clear, no odor
		5	NS	NS	NS	NS	NS	NS	Not in sampling plan
MW-H	Former Celotex	1	NS	NS	NS	NS	NS	NS	Not in sampling plan
		2	NS	NS	NS	NS	NS	NS	Not in sampling plan
		3	NS	NS	NS	NS	NS	NS	Not in sampling plan
		4	NS	NS	NS	NS	NS	NS	Not in sampling plan
		5	6.46	16.77	4.948	-110.4	3.80	20.40	Clear, no odor
MW-I	Former Celotex	1	NS	NS	NS	NS	NS	NS	Not in sampling plan
		2	7.57	11.83	3.43	31	0.49	6.5	Clear, no odor
		3	7.36	13.56	0.42	68	8.35	22.00	Tan, no odor
		4	6.95	19.65	0.5	87.20	3.28	7.56	Clear, no odor
		5	NS	NS	NS	NS	NS	NS	Not in sampling plan
MW-J	Former Celotex	1	NS	NS	NS	NS	NS	NS	Not in sampling plan
		2	7.16	11.10	7.49	117	3.40	4.1	Clear, no odor
		3	7.59	12.19	3.62	46	10.30	15.00	Tan, no odor
		4	6.39	19.89	2.73	-34.40	1.92	9.90	clear, no odor
		5	NS	NS	NS	NS	NS	NS	Not in sampling plan
MW-K	Former Celotex	1	NS	NS	NS	NS	NS	NS	Not in sampling plan
		2	NS	NS	NS	NS	NS	NS	Not in sampling plan
		3	NS	NS	NS	NS	NS	NS	Not in sampling plan
		4	NS	NS	NS	NS	NS	NS	Not in sampling plan
		5	6.52	17.46	2.217	-145.9	*	6.35	Clear, product and organic odor
MW-L	Former Celotex	1	NS	NS	NS	NS	NS	NS	Not in sampling plan
		2	7.09	14.50	2.81	-301	0.00	6.6	Clear, strong product odor
		3	7.47	15.50	3.25	-273	3.21	11.00	Yellow, sulfur odor
		4	6.41	19.37	2	-285	*	0.00	Black, product and sulfur odor
		5	6.93	19.30	3	-318.90	4.81	1.07	Clear, product odor
MW-M	Former Celotex	1	NS	NS	NS	NS	NS	NS	Not in sampling plan
		2	NS	NS	NS	NS	NS	NS	Not in sampling plan
		3	NS	NS	NS	NS	NS	NS	Not in sampling plan
		4	NS	NS	NS	NS	NS	NS	Not in sampling plan
		5	8.08	16.87	540.116	43.90	0.43	1.63	Clear, no odor



TABLE 2-5

Summary of Groundwater and Standing Water Quality Field Parameter Results

Quanta Resources Superfund Site, OU1

Edgewater, New Jersey

Sample Location	Property	Sampling Event	pH	Temp. (° C)	Cond. (mS/cm)	ORP (mV)	DO (mg/L)	Turbidity (NTU)	Comments
MW-N-1	Former Celotex	1	NS	NS	NS	NS	NS	NS	Not in sampling plan
		2	NS	NS	NS	NS	NS	NS	Not in sampling plan
		3	NS	NS	NS	NS	NS	NS	Not in sampling plan
		4	NS	NS	NS	NS	NS	NS	Not in sampling plan
		5	6.36	17.19	0.9118	-130.0	0.00	12.80	Cloudy, no odor
MW-N-2	Former Celotex	1	NS	NS	NS	NS	NS	NS	Not in sampling plan
		2	NS	NS	NS	NS	NS	NS	Not in sampling plan
		3	NS	NS	NS	NS	NS	NS	Not in sampling plan
		4	NS	NS	NS	NS	NS	NS	Not in sampling plan
		5	7.06	20.58	2.182	-176.9	1.31	16.40	Clear, product odor
MW-N-3	Former Celotex	1	NS	NS	NS	NS	NS	NS	Not in sampling plan
		2	NS	NS	NS	NS	NS	NS	Not in sampling plan
		3	NS	NS	NS	NS	NS	NS	Not in sampling plan
		4	NS	NS	NS	NS	NS	NS	Not in sampling plan
		5	14.47	16.19	0.545	-239.0	0.00	8.12	Clear, no odor
MW-O	Former Celotex	1	NS	NS	NS	NS	NS	NS	Not in sampling plan
		2	NS	NS	NS	NS	NS	NS	Not in sampling plan
		3	NS	NS	NS	NS	NS	NS	Not in sampling plan
		4	NS	NS	NS	NS	NS	NS	Not in sampling plan
		5	6.30	17.78	2.705	-168.9	*	3.85	Clear, product and organic odor
ACMW-1	Former Celotex	1	NS	NS	NS	NS	NS	NS	Not in sampling plan
		2	NS	NS	NS	NS	NS	NS	Not in sampling plan
		3	NS	NS	NS	NS	NS	NS	Not in sampling plan
		4	NS	NS	NS	NS	NS	NS	Not in sampling plan
		5	3.93	15.52	3.062	224.1	4.66	17.20	Cloudy white, no odor
ACMW-3	Former Celotex	1	NS	NS	NS	NS	NS	NS	Not in sampling plan
		2	NS	NS	NS	NS	NS	NS	Not in sampling plan
		3	NS	NS	NS	NS	NS	NS	Not in sampling plan
		4	NS	NS	NS	NS	NS	NS	Not in sampling plan
		5	6.72	16.22	1.645	98.7	1.21	0.00	Clear, no odor
DMW-2	Former Celotex	1	NS	NS	NS	NS	NS	NS	Not in sampling plan
		2	NS	NS	NS	NS	NS	NS	Not in sampling plan
		3	NS	NS	NS	NS	NS	NS	Not in sampling plan
		4	NS	NS	NS	NS	NS	NS	Not in sampling plan
		5	7.78	15.75	2.763	-255.0	*	130.00	Clear, no odor
SW-A*	Quanta	1	5.46	9.80	0.43	-186	11.05	N/A	
		2	NS	NS	NS	NS	NS	NS	Not in sampling plan
		3	NS	NS	NS	NS	NS	NS	Not in sampling plan
		4	NS	NS	NS	NS	NS	NS	Not in sampling plan
		5	NS	NS	NS	NS	NS	NS	Not in sampling plan
SW-B*	Quanta	1	6.35	10.52	0.25	-255	12.06	N/A	
		2	NS	NS	NS	NS	NS	NS	Not in sampling plan
		3	NS	NS	NS	NS	NS	NS	Not in sampling plan
		4	NS	NS	NS	NS	NS	NS	Not in sampling plan
		5	NS	NS	NS	NS	NS	NS	Not in sampling plan
SW-C*	Quanta	1	7.15	12.35	0.27	-230	11.52	N/A	
		2	NS	NS	NS	NS	NS	NS	Not in sampling plan
		3	NS	NS	NS	NS	NS	NS	Not in sampling plan
		4	NS	NS	NS	NS	NS	NS	Not in sampling plan
		5	NS	NS	NS	NS	NS	NS	Not in sampling plan
SW-D*	Quanta	1	7.78	12.33	0.04	-250	10.93	N/A	
		2	NS	NS	NS	NS	NS	NS	Not in sampling plan
		3	NS	NS	NS	NS	NS	NS	Not in sampling plan
		4	NS	NS	NS	NS	NS	NS	Not in sampling plan
		5	NS	NS	NS	NS	NS	NS	Not in sampling plan

**TABLE 2-5**

Summary of Groundwater and Standing Water Quality Field Parameter Results

*Quanta Resources Superfund Site, OU1**Edgewater, New Jersey*

Sample Location	Property	Sampling Event	pH	Temp. (° C)	Cond. (mS/cm)	ORP (mV)	DO (mg/L)	Turbidity (NTU)	Comments
TWP-SB28	Block 93 North	6	6.69	21.67	0.033	-150.1	0.99	38.7	Clear/None
TWP-SB29	Block 93 North	6	6.67	18.31	6.819	-171.9	1.07	13	Clear/None
TWP-SB30	Block 93 North	6	6.83	17.89	0.018	-180.8	0.17	116	Clear/None
TWP-SB31	Block 93 North	6	7.25	15.09	0.43	-182	4.02	19	Clear/None
TWP-SB32	Block 93 North	6	7.13	15.81	1.604	-180.8	2	17.3	Clear/None
TWP-SB33	Block 93 North	6	8.02	18.96	1.212	120.7	1.95	12	Clear/None

**Notes:**

Event 1: Sampling conducted November 15 to December 30, 2005

Event 2: Sampling conducted February 13 to March 15, 2006

Event 3: Sampling conducted May 15 to 24, 2006

Event 4: Sampling conducted August 14 to 20, 2006

Event 5: Sampling conducted October 23 to 27, 2006

Event 6: Sampling of temporary well points conducted June 4 to 5, 2007

All sampling conducted in accordance with applicable sampling plans

Parameters measured with Horiba U-22 during Event 1, 2 and 3. Parameters measured with YSI-556 during Events 4, 5, and 6.

Wells with product present were not sampled during sampling events 3 through 5.

\* - Results unavailable due to malfunctioning equipment.

mL/min - milliliters per minute

mS/cm - milliSiemens per centimeter

mV - millivolt

N/A - Not applicable

NS - Not sampled

NTU - Nephelometric turbidity unit

SW - Surface water samples from seasonal standing water

**TABLE 2-6**

Summary of NAPL Samples and Analyses  
*Quanta Resources Superfund Site, OU1*  
*Edgewater, New Jersey*

Location ID	Field Sample ID	Date Sampled	Chemical Analyses					Physical Parameters					
			VOCs	Extended SVOCs	Biomarkers	PCBs	TAL Metals	Kinematic Viscosity @ 122 °F	Viscosity SFS @ 122 °F	Interfacial Tension	API Gravity @ 60 °F	Density @ 60 °F	Specific Gravity @ 60 °F
MW-102	PA031121-05 1:10	11/20/03		O									
MW-103	PA031121-06 1:10	11/20/03		O									
MW-104	PA031121-01 1:10	11/20/03		O									
MW-105	PA031121-04 1:10	11/20/03		O									
SEEP-1	PA031121-02	11/20/03		O									
SEEP-2	PA031121-03 1:10	11/20/03		O									
MW-102A	MW-102AD-112305	11/23/05	X	X		X	X	X	X	X	X	X	X
MW-105	MW-105D-112305	11/23/05	X	X		X	X	X	X	X	X	X	X
MW-112B	MW-112BD-112305	11/23/05	X	X		X	X	X	X	X	X	X	X
MW-116B	MW-116BD-112305	11/23/05	X	X		X	X	X	X	X	X	X	X
MW-107	MW-107D-120605	12/06/05	X	X		X	X	X	X	X	X	X	X
MW-7	MW-7L-052406	05/24/06	X	X	X	X	X	X	X	X	X	X	X

**Notes:**

Sampling conducted in 2003 was performed by Parsons.

Analytical methods utilized are as follows:

API Gravity: Method ASTM-D4052

Biomarkers: Method SW8270M

Density: Method ASTM-D4052

Extended SVOCs: Method SW8270

Interfacial Tension: Method ASTM-D971

Kinematic Viscosity: Method ASTM-D445

PCBs: Method SW8082

Specific Gravity: Method ASTM-D4052

TAL Metals: Method SW6010 and SW3050/7471

Viscosity: Method ASTM-D2161

VOCs: Method SW8260

API - American Petroleum Institute

PCB - polychlorinated biphenyl

SVOC - semi-volatile organic compound

TAL - Target Analyte List SW-846

VOC - volatile organic compound

o - Only select SVOC parameters were analyzed:

1,2,4-Trimethylbenzene, 1-Methylnaphthalene, 2-Methylnaphthalene, Acenaphthalene, Acenaphthylene, Anthracene, Benzene, Benzo(a)anthracene, Benzo(a)pyrene, Benzo(b)fluoranthene, Benzo(g,h,i)perylene, Benzo(k)fluoranthene, C1-Dibenzothiophenes, C1-Fluoranthenes/pyrenes, C1-Fluorenes, C1-Naphthalenes, C1-Phenanthrenes/anthracenes, C2-Benz(a)anthracene/chrysene, C2-Dibenzothiophenes, C2-Fluoranthenes/pyrenes, C2-Fluorenes, C2-Naphthalenes, C2-Phenanthrenes/anthracenes, C3-Dibenzothiophenes, C3-Fluoranthenes/pyrenes, C3-Fluorenes, C3-Naphthalenes, Chrysene, Dibenzothiophene, Dibenzo(a,h)anthracene, Dibenzofuran, Ethylbenzene, Fluoranthene, Fluorene, Indeno(1,2,3-cd)pyrene, Naphthalene, O-Xylene, Perylene, Phenanthrene, Styrene, Toluene, Xylenes, m & p

**TABLE 3-1**

Summary of Hydraulic Conductivity Values  
*Quanta Resources Superfund Site, OU1*  
*Edgewater, New Jersey*

Well Name	Hydraulic Conductivity (feet per day)	Geometric Mean Hydraulic Conductivity (feet per day)
Shallow Unconfined		
MW-102A	8	51
MW-103	109	
MW-103A	57	
MW-107	239	
MW-107A	114	
MW-113A	34	
MW-116A	20	
Deep Unconfined		
MW-102B	51	9
MW-116B	2	
MW-113B	10	
MW-113C	5	
Deep Sand Unit		
MW-103DS	19	8
MW-107DS	5	
MW-116DS	5	

Note:

The average of the results from all rising and falling head tests at each location was used to determine hydraulic conductivity for that location. Data was interpreted using the Bouwer, H. and R.C. Rice method (1976).

**TABLE 3-2**

Synoptic Water Levels - High Tide  
 Quanta Resources Superfund Site, OU1  
 Edgewater, New Jersey

Well Name	December 30, 2005 (07:35 - 10:46)			March 15, 2006 (08:15 - 10:46)			May 24, 2006 (06:59 - 08:25)			August 14, 2006 (11:07 - 14:30)		
	DTW (ft)	Measuring Point Elevation (ft msl)	GW Elevation (ft msl)	DTW (ft)	Measuring Point Elevation (ft msl)	GW Elevation (ft msl)	DTW (ft)	Measuring Point Elevation (ft msl)	GW Elevation (ft msl)	DTW (ft)	Measuring Point Elevation (ft msl)	GW Elevation (ft msl)
<b>Shallow (Unconfined) Overburden Unit</b>												
MW-101A	5.19	10.63	5.44	5.90	10.63	4.73	5.45	10.63	5.18	5.64	10.63	4.99
MW-102A	4.32	9.69	5.37	5.35	9.69	4.34	4.39	9.69	5.30	4.65	9.69	5.04
MW-103A	3.90	10.03	6.13	4.94	10.03	5.09	4.54	10.03	5.49	5.05	10.03	4.98
MW-105A	5.54	8.20	2.66	6.52	8.20	1.68	6.01	8.20	2.19	6.10	8.20	2.10
MW-106A	5.30	6.65	1.35	6.13	6.65	0.52	5.46	6.65	1.19	5.39	6.65	1.26
MW-107A	3.57	7.04	3.47	4.10	7.04	2.94	3.71	7.04	3.33	3.90	7.04	3.14
MW-108	NM	7.17	NM	NM	7.17	NM	4.04	7.17	3.13	4.28	7.17	2.89
MW-109A	2.80	4.56	1.76	4.42	4.56	0.14	3.59	4.56	0.97	3.90	4.56	0.66
MW-111A	2.54	7.98	5.44	3.40	7.98	4.58	2.90	7.98	5.08	3.33	7.98	4.65
MW-112A	4.02	10.01	5.99	5.01	10.01	5.00	4.67	10.01	5.34	5.02	10.01	4.99
MW-113A	4.86	10.20	5.34	5.64	10.20	4.56	5.25	10.20	4.95	5.53	10.20	4.67
MW-114A	NM	7.41	NM	3.17	7.41	4.24	2.45	7.41	4.96	3.10	7.41	4.31
MW-115A	NM	7.14	NM	5.55	7.14	1.59	5.11	7.14	2.03	5.29	7.14	1.85
MW-116A	4.99	9.45	4.46	6.22	9.45	3.23	5.44	9.45	4.01	5.72	9.45	3.73
MW-117A	4.78	9.37	4.59	6.22	9.37	3.15	5.25	9.37	4.12	5.60	9.37	3.77
MW-118A	5.12	9.00	3.88	6.84	9.00	2.16	6.56	9.00	2.44	5.71	9.00	3.29
MW-119A	4.45	6.00	1.55	5.35	6.00	0.65	4.67	6.00	1.33	NM	6.00	NM
MW-120A	5.41	6.83	1.42	6.39	6.83	0.44	5.59	6.83	1.24	5.65	6.83	1.18
MW-121A	NM	7.13	NM	3.03	7.13	4.10	2.58	7.13	4.55	2.88	7.13	4.25
MW-122A	3.30	7.24	3.94	3.79	7.24	3.45	3.41	7.24	3.83	3.55	7.24	3.69
MW-A-2*	NM	17.29	NM	12.71	17.29	4.58	12.28	17.29	5.01	12.52	17.29	4.77
MW-B*	NM	15.40	NM	10.77	15.40	4.63	10.44	15.40	4.96	10.71	15.40	4.69
MW-C*	NM	14.75	NM	13.21	14.75	1.54	12.60	14.75	2.15	12.69	14.75	2.06
MW-D*	NM	15.27	NM	10.90	15.27	4.37	10.47	15.27	4.80	10.52	15.27	4.75
MW-F*	NM	11.29	NM	10.31	11.29	0.98	9.81	11.29	1.48	9.39	11.29	1.90
MW-G*	NM	13.91	NM	9.86	13.91	4.05	9.49	13.91	4.42	9.64	13.91	4.27
MW-I*	NM	19.13	NM	17.28	19.13	1.85	16.70	19.13	2.43	16.40	19.13	2.73
MW-J*	NM	16.09	NM	14.22	16.09	1.87	13.86	16.09	2.23	13.59	16.09	2.50
MW-L*	NM	15.05	NM	10.20	15.05	4.85	9.94	15.05	5.11	10.10	15.05	4.95
MW-26	NM	9.57	NM	NM	9.57	NM	NM	9.57	NM	5.33	9.57	4.24
MW-29	NM	7.09	NM	NM	7.09	NM	NM	7.09	NM	3.20	7.09	3.89
MW-31	NM	7.10	NM	NM	7.10	NM	NM	7.10	NM	3.88	7.10	3.22
MW-32	NM	6.30	NM	NM	6.30	NM	NM	6.30	NM	3.75	6.30	2.55
MW-36	NM	7.37	NM	NM	7.37	NM	NM	7.37	NM	3.94	7.37	3.43
MW-7	NM	6.94	NM	NM	6.94	NM	NM	6.94	NM	5.91	6.94	1.03

**TABLE 3-2**

Synoptic Water Levels - High Tide  
 Quanta Resources Superfund Site, OU1  
 Edgewater, New Jersey

Well Name	December 30, 2005 (07:35 - 10:46)			March 15, 2006 (08:15 - 10:46)			May 24, 2006 (06:59 - 08:25)			August 14, 2006 (11:07 - 14:30)		
	DTW (ft)	Measuring Point Elevation (ft msl)	GW Elevation (ft msl)	DTW (ft)	Measuring Point Elevation (ft msl)	GW Elevation (ft msl)	DTW (ft)	Measuring Point Elevation (ft msl)	GW Elevation (ft msl)	DTW (ft)	Measuring Point Elevation (ft msl)	GW Elevation (ft msl)
MW-25	NM	7.09	NM	NM	7.09	NM	NM	7.09	NM	4.73	7.09	2.36
MW-30	NM	6.27	NM	NM	6.27	NM	NM	6.27	NM	4.84	6.27	1.43
ACMW-1	NM	11.29	NM	NM	11.29	NM	NM	11.29	NM	NM	11.29	NM
ACMW-3	NM	14.34	NM	NM	14.34	NM	NM	14.34	NM	NM	14.34	NM
MW-20	NM	15.05	NM	NM	15.05	NM	NM	15.05	NM	NM	15.05	NM
MW-22A	NM	10.35	NM	NM	10.35	NM	NM	10.35	NM	NM	10.35	NM
MW-36EE	NM	14.14	NM	NM	14.14	NM	NM	14.14	NM	NM	14.14	NM
MW-E	NM	14.96	NM	NM	14.96	NM	NM	14.96	NM	NM	14.96	NM
MW-H	NM		NM	NM		NM	NM		NM	NM		NM
MW-K	NM	13.92	NM	NM	13.92	NM	NM	13.92	NM	NM	13.92	NM
MW-M	NM	15.56	NM	NM	15.56	NM	NM	15.56	NM	NM	15.56	NM
MW-N-2	NM	11.42	NM	NM	11.42	NM	NM	11.42	NM	NM	11.42	NM
MW-O	NM	15.51	NM	NM	15.51	NM	NM	15.51	NM	NM	15.51	NM
<b>Deep (Unconfined) Overburden Unit</b>												
MW-102	4.32	9.24	4.92	4.96	9.24	4.28	4.56	9.24	4.68	4.94	9.24	4.30
MW-102B	5.69	9.61	3.92	5.35	9.61	4.26	4.95	9.61	4.66	5.16	9.61	4.45
MW-103	3.59	8.57	4.98	4.29	8.57	4.28	3.90	8.57	4.67	4.18	8.57	4.39
MW-104R	5.84	9.11	3.27	7.38	9.11	1.73	6.51	9.11	2.60	5.43	9.11	3.68
MW-105	5.32	5.03	-0.29	6.23	5.03	-1.20	5.80	5.03	-0.77	NM	5.03	NM
MW-106	5.50	7.13	1.63	6.60	7.13	0.53	5.92	7.13	1.21	5.84	7.13	1.29
MW-107	2.73	6.84	4.11	3.25	6.84	3.59	2.88	6.84	3.96	2.99	6.84	3.85
MW-109	7.24	4.49	-2.75	8.43	4.49	-3.94	8.06	4.49	-3.57	12.40	4.49	-7.91
MW-111B	2.45	7.85	5.40	NM	7.85	NM	2.80	7.85	5.05	3.20	7.85	4.65
MW-112B	3.93	9.60	5.67	4.82	9.60	4.78	4.41	9.60	5.19	4.61	9.60	4.99
MW-113B	4.86	9.94	5.08	5.37	9.94	4.57	5.00	9.94	4.94	5.28	9.94	4.66
MW-113C	4.54	9.80	5.26	5.29	9.80	4.51	4.93	9.80	4.87	5.08	9.80	4.72
MW-114B	NM	7.24	NM	4.16	7.24	3.08	2.62	7.24	4.62	2.99	7.24	4.25
MW-115B	NM	6.70	NM	3.38	6.70	3.32	2.89	6.70	3.81	2.99	6.70	3.71
MW-116B	4.53	8.69	4.16	5.60	8.69	3.09	4.73	8.69	3.96	5.95	8.69	2.74
MW-117B	4.52	9.04	4.52	5.93	9.04	3.11	5.03	9.04	4.01	5.33	9.04	3.71
MW-118B	6.65	9.40	2.75	7.71	9.40	1.69	7.14	9.40	2.26	7.25	9.40	2.15
MW-119B	4.12	5.68	1.56	5.06	5.68	0.62	4.37	5.68	1.31	4.29	5.68	1.39
MW-120B	5.41	6.78	1.37	6.29	6.78	0.49	5.58	6.78	1.20	5.52	6.78	1.26
MW-121B	NM	7.16	NM	3.03	7.16	4.13	2.68	7.16	4.48	2.95	7.16	4.21

**TABLE 3-2**

Synoptic Water Levels - High Tide  
 Quanta Resources Superfund Site, OU1  
 Edgewater, New Jersey

Well Name	December 30, 2005 (07:35 - 10:46)			March 15, 2006 (08:15 - 10:46)			May 24, 2006 (06:59 - 08:25)			August 14, 2006 (11:07 - 14:30)		
	DTW (ft)	Measuring Point Elevation (ft msl)	GW Elevation (ft msl)	DTW (ft)	Measuring Point Elevation (ft msl)	GW Elevation (ft msl)	DTW (ft)	Measuring Point Elevation (ft msl)	GW Elevation (ft msl)	DTW (ft)	Measuring Point Elevation (ft msl)	GW Elevation (ft msl)
<b>Deep Sand Unit</b>												
MW-101DS	4.80	10.45	5.65	5.71	10.45	4.74	5.21	10.45	5.24	5.41	10.45	5.04
MW-103DS	4.59	10.13	5.54	5.57	10.13	4.56	4.97	10.13	5.16	5.21	10.13	4.92
MW-107DS	1.49	6.82	5.33	2.23	6.82	4.59	1.70	6.82	5.12	2.30	6.82	4.52
MW-116DS	4.04	9.18	5.14	5.00	9.18	4.18	4.37	9.18	4.81	4.49	9.18	4.69
MW-N-1	NM	12.00	NM	NM	12.00	NM	NM	12.00	NM	NM	12.00	NM
MW-A-1	NM	16.06	NM	11.40	16.06	4.66	10.95	16.06	5.11	11.10	16.06	4.96
<b>Tidal Gauge</b>												
TGS-1	9.12	12.58	3.46	11.03	12.58	1.55	10.20	12.58	2.38	9.73	12.58	2.85
<b>Unknown Well</b>												
DMW-2	NM	14.14	NM	NM	14.14	NM	NM	14.14	NM	NM	14.14	NM
<b>Bedrock Well</b>												
MW-N3	NM	13.34	NM	NM	13.34	NM	NM	13.34	NM	NM	13.34	NM

Notes:

\* - Monitoring well not accessible

\*\* - Elevation of water in Hudson River

Depth to water measurements reported in feet below top of inner monitoring well casing or "measuring point".

Depth to water measurements taken during high tide: December 30, 2005, 07:39; March 15, 2006, 08:57; May 24, 2006, 06:59; August 14, 2006, 14:00

DTW - depth to water

ft msl - Feet referenced to mean sea level

NM - Not measured

Vertical datum: NAVD 88

**TABLE 3-3**

Synoptic Water Levels - Low Tide  
 Quanta Resources Superfund Site, OU1  
 Edgewater, New Jersey

Well Name	December 30, 2005 (14:00 - 14:40)			March 15, 2006 (14:16 - 16:59)			May 24, 2006 (12:29 - 14:05)			August 14, 2006 (18:02 - 20:10)		
	DTW (ft)	Measuring Point TIC Elevation (ft msl)	GW Elevation (ft msl)	DTW (ft)	Measuring Point TIC Elevation (ft msl)	GW Elevation (ft msl)	DTW (ft)	Measuring Point TIC Elevation (ft msl)	GW Elevation (ft msl)	DTW (ft)	Measuring Point TIC Elevation (ft msl)	GW Elevation (ft msl)
<b>Shallow (Unconfined) Overburden Unit</b>												
MW-101A	5.10	10.63	5.53	5.92	10.63	4.71	5.47	10.63	5.16	5.64	10.63	4.99
MW-102A	3.97	9.69	5.72	5.24	9.69	4.45	4.44	9.69	5.25	4.67	9.69	5.02
MW-103A	4.32	10.03	5.71	4.94	10.03	5.09	4.54	10.03	5.49	5.09	10.03	4.94
MW-105A	5.69	8.20	2.51	6.52	8.20	1.68	6.12	8.20	2.08	6.2	8.20	2
MW-106A	5.39	6.65	1.26	6.22	6.65	0.43	5.55	6.65	1.1	5.32	6.65	1.33
MW-107A	3.58	7.04	3.46	4.12	7.04	2.92	3.7	7.04	3.34	3.9	7.04	3.14
MW-108	NM	7.17	NM	NM	7.17	NM	4.06	7.17	3.11	4.4	7.17	2.77
MW-109A	5.89	4.56	-1.33	5.90	4.56	-1.34	5.71	4.56	-1.15	5.5	4.56	-0.94
MW-111A	7.98	7.98	0.00	3.36	7.98	4.62	2.92	7.98	5.06	3.32	7.98	4.66
MW-112A	4.13	10.01	5.88	5.04	10.01	4.97	4.69	10.01	5.32	5.01	10.01	5
MW-113A	4.86	10.20	5.34	5.64	10.20	4.56	5.26	10.20	4.94	5.53	10.20	4.67
MW-114A	NM	7.41	NM	4.16	7.41	3.25	2.6	7.41	4.81	3.1	7.41	4.31
MW-115A	NM	7.14	NM	5.57	7.14	1.57	5.14	7.14	2	5.3	7.14	1.84
MW-116A	5.02	9.45	4.43	6.22	9.45	3.23	5.41	9.45	4.04	5.79	9.45	3.66
MW-117A	4.81	9.37	4.56	6.22	9.37	3.15	5.3	9.37	4.07	5.68	9.37	3.69
MW-118A	5.22	9.00	3.78	6.87	9.00	2.13	8.59	9.00	0.41	5.76	9.00	3.24
MW-119A	4.74	6.00	1.26	5.51	6.00	0.49	4.87	6.00	1.13	NM	6.00	NM
MW-120A	5.70	6.83	1.13	6.51	6.83	0.32	5.87	6.83	0.96	5.6	6.83	1.23
MW-121A	NM	7.13	NM	3.05	7.13	4.08	2.62	7.13	4.51	2.87	7.13	4.26
MW-122A	3.30	7.24	3.94	3.79	7.24	3.45	3.35	7.24	3.89	3.52	7.24	3.72
MW-A-2*	NM	17.29	NM	12.72	17.29	4.57	12.26	17.29	5.03	12.51	17.29	4.78
MW-B*	NM	15.40	NM	10.79	15.40	4.61	10.43	15.40	4.97	10.69	15.40	4.71
MW-C*	NM	14.75	NM	13.24	14.75	1.51	12.64	14.75	2.11	12.62	14.75	2.13
MW-D*	NM	15.27	NM	10.94	15.27	4.33	10.5	15.27	4.77	10.53	15.27	4.74
MW-F*	NM	11.29	NM	10.35	11.29	0.94	9.84	11.29	1.45	9.56	11.29	1.73
MW-G*	NM	13.91	NM	9.87	13.91	4.04	9.5	13.91	4.41	9.7	13.91	4.21
MW-I*	NM	19.13	NM	17.31	19.13	1.82	16.74	19.13	2.39	16.43	19.13	2.7
MW-J*	NM	16.09	NM	14.29	16.09	1.8	13.89	16.09	2.2	13.6	16.09	2.49
MW-L*	NM	15.05	NM	10.31	15.05	4.74	9.95	15.05	5.1	9.98	15.05	5.07
MW-26	NM	9.57	NM	NM	9.57	NM	NM	9.57	NM	5.32	9.57	4.25
MW-29	NM	7.09	NM	NM	7.09	NM	NM	7.09	NM	3.22	7.09	3.87
MW-31	NM	7.10	NM	NM	7.10	NM	NM	7.10	NM	3.89	7.10	3.21
MW-32	NM	6.30	NM	NM	6.30	NM	NM	6.30	NM	3.83	6.30	2.47
MW-36	NM	7.37	NM	NM	7.37	NM	NM	7.37	NM	3.81	7.37	3.56
MW-7	NM	6.94	NM	NM	6.94	NM	NM	6.94	NM	5.82	6.94	1.12



**TABLE 3-3**

Synoptic Water Levels - Low Tide  
 Quanta Resources Superfund Site, OU1  
 Edgewater, New Jersey

Well Name	December 30, 2005 (14:00 - 14:40)			March 15, 2006 (14:16 - 16:59)			May 24, 2006 (12:29 - 14:05)			August 14, 2006 (18:02 - 20:10)		
	DTW (ft)	Measuring Point TIC Elevation (ft msl)	GW Elevation (ft msl)	DTW (ft)	Measuring Point TIC Elevation (ft msl)	GW Elevation (ft msl)	DTW (ft)	Measuring Point TIC Elevation (ft msl)	GW Elevation (ft msl)	DTW (ft)	Measuring Point TIC Elevation (ft msl)	GW Elevation (ft msl)
MW-25	NM	7.09	NM	NM	7.09	NM	NM	7.09	NM	4.76	7.09	2.33
MW-30	NM	6.27	NM	NM	6.27	NM	NM	6.27	NM	5.02	6.27	1.25
ACMW-1	NM	11.29	NM	NM	11.29	NM	NM	11.29	NM	NM	11.29	NM
ACMW-3	NM	14.34	NM	NM	14.34	NM	NM	14.34	NM	NM	14.34	NM
MW-20	NM	15.05	NM	NM	15.05	NM	NM	15.05	NM	NM	15.05	NM
MW-22A	NM	10.35	NM	NM	10.35	NM	NM	10.35	NM	NM	10.35	NM
MW-36EE	NM	14.14	NM	NM	14.14	NM	NM	14.14	NM	NM	14.14	NM
MW-E	NM	14.96	NM	NM	14.96	NM	NM	14.96	NM	NM	14.96	NM
MW-H	NM		NM	NM		NM	NM		NM	NM		NM
MW-K	NM	13.92	NM	NM	13.92	NM	NM	13.92	NM	NM	13.92	NM
MW-M	NM	15.56	NM	NM	15.56	NM	NM	15.56	NM	NM	15.56	NM
MW-N-2	NM	11.42	NM	NM	11.42	NM	NM	11.42	NM	NM	11.42	NM
MW-O	NM	15.51	NM	NM	15.51	NM	NM	15.51	NM	NM	15.51	NM
<b>Deep (Unconfined) Overburden Unit</b>												
MW-102	4.28	9.24	4.96	4.94	9.24	4.30	4.82	9.24	4.42	4.89	9.24	4.35
MW-102B	4.68	9.61	4.93	5.31	9.61	4.30	4.92	9.61	4.69	5.14	9.61	4.47
MW-103	3.56	8.57	5.01	4.27	8.57	4.30	3.87	8.57	4.70	4.18	8.57	4.39
MW-104R	5.90	9.11	3.21	7.36	9.11	1.75	6.50	9.11	2.61	5.44	9.11	3.67
MW-105	5.54	5.03	-0.51	6.24	5.03	-1.21	5.89	5.03	-0.86	NM	5.03	NM
MW-106	5.60	7.13	1.53	6.67	7.13	0.46	6.01	7.13	1.12	5.78	7.13	1.35
MW-107	2.71	6.84	4.13	3.24	6.84	3.60	2.81	6.84	4.03	2.98	6.84	3.86
MW-109	5.60	4.49	-1.11	8.08	4.49	-3.59	7.63	4.49	-3.14	9.90	4.49	-5.41
MW-111B	2.46	7.85	5.39	3.29	7.85	4.56	2.81	7.85	5.04	3.21	7.85	4.64
MW-112B	3.94	9.60	5.66	4.83	9.60	4.77	4.39	9.60	5.21	4.65	9.60	4.95
MW-113B	4.60	9.94	5.34	5.36	9.94	4.58	5.03	9.94	4.91	5.27	9.94	4.67
MW-113C	4.57	9.80	5.23	5.30	9.80	4.50	4.93	9.80	4.87	5.08	9.80	4.72
MW-114B	NM	7.24	NM	3.11	7.24	4.13	2.77	7.24	4.47	2.97	7.24	4.27
MW-115B	NM	6.70	NM	3.22	6.70	3.48	2.79	6.70	3.91	2.94	6.70	3.76
MW-116B	4.61	8.69	4.08	5.58	8.69	3.11	4.91	8.69	3.78	5.28	8.69	3.41
MW-117B	4.54	9.04	4.50	5.95	9.04	3.09	5.01	9.04	4.03	5.37	9.04	3.67
MW-118B	6.84	9.40	2.56	7.74	9.40	1.66	7.33	9.40	2.07	7.26	9.40	2.14
MW-119B	4.55	5.68	1.13	5.28	5.68	0.40	4.66	5.68	1.02	4.18	5.68	1.50
MW-120B	5.50	6.78	1.28	6.34	6.78	0.44	5.68	6.78	1.10	5.43	6.78	1.35
MW-121B	NM	7.16	NM	3.04	7.16	4.12	2.66	7.16	4.50	2.90	7.16	4.26

**TABLE 3-3**

Synoptic Water Levels - Low Tide  
 Quanta Resources Superfund Site, OU1  
 Edgewater, New Jersey

Well Name	December 30, 2005 (14:00 - 14:40)			March 15, 2006 (14:16 - 16:59)			May 24, 2006 (12:29 - 14:05)			August 14, 2006 (18:02 - 20:10)		
	DTW (ft)	Measuring Point TIC Elevation (ft msl)	GW Elevation (ft msl)	DTW (ft)	Measuring Point TIC Elevation (ft msl)	GW Elevation (ft msl)	DTW (ft)	Measuring Point TIC Elevation (ft msl)	GW Elevation (ft msl)	DTW (ft)	Measuring Point TIC Elevation (ft msl)	GW Elevation (ft msl)
<b>Deep Sand Unit</b>												
MW-101DS	4.91	10.45	5.54	5.74	10.45	4.71	5.29	10.45	5.16	5.46	10.45	4.99
MW-103DS	5.09	10.13	5.04	5.81	10.13	4.32	5.39	10.13	4.74	5.52	10.13	4.61
MW-107DS	1.59	6.82	5.23	2.37	6.82	4.45	1.77	6.82	5.05	2.27	6.82	4.55
MW-116DS	4.81	9.18	4.37	5.41	9.18	3.77	5.06	9.18	4.12	5.12	9.18	4.06
MW-N-1	NM	12.00	NM	NM	12.00	NM	NM	12.00	NM	NM	12.00	NM
MW-A-1	NM	16.06	NM	11.39	16.06	4.67	10.91	16.06	5.15	11.10	16.06	4.96
<b>Tidal Gauge</b>												
TGS-1	15.65	12.58	-3.07	14.62^	12.58	ND	15.65	12.58	-3.07	13.55	12.58	-0.97
<b>Unknown Well</b>												
DMW-2	NM	14.14	NM	NM	14.14	NM	NM	14.14	NM	NM	14.14	NM
<b>Bedrock Well</b>												
MW-N3	NM	13.34	NM	NM	13.34	NM	NM	13.34	NM	NM	13.34	NM

Notes:

\* - Monitoring well not accessible

\*\* - Elevation of water in Hudson River

Depth to water measurements reported in feet below top of inner monitoring well casing or "measuring point".

Depth to water measurements taken during low tide: December 30, 2005, 14:23; March 15, 2006, 15:17; May 24, 2006, 13:11; August 14, 2006, 20:00

DTW - depth to water

ft msl - Feet referenced to mean sea level

NM - Not measured

Vertical datum: NAVD 88

TABLE 3-4  
Calculated Vertical Hydraulic Gradients  
Quanta Resources Superfund Site  
Edgewater, New Jersey

Location	Monitoring Wells	Ground Surface Elevation (ft msl)	Mid-point of Screened Interval (ft bgs)	Elevation of Mid-point of Screened Interval (ft msl)	December 30, 2005										March 15, 2006									
					Low-Tide Conditions (14:23)					High-Tide Conditions (07:39)					Low-Tide Conditions (15:17)					High-Tide Conditions (08:57)				
					Groundwater Elevation (ft msl)	Head Difference (ft)	Screen Elevation Difference (ft)	Vertical Gradient	Vertical Direction	Groundwater Elevation (ft msl)	Head Difference (ft)	Elevation Difference (ft)	Vertical Gradient	Vertical Direction	Groundwater Elevation (ft msl)	Head Difference (ft)	Elevation Difference (ft)	Vertical Gradient	Vertical Direction	Groundwater Elevation (ft msl)	Head Difference (ft)	Elevation Difference (ft)	Vertical Gradient	Vertical Direction
Within Unconfined Aquifer																								
MW-102	MW-102B	6.8	19.0	-12.2	4.96	-0.79	12.0	-0.07	DOWN	3.95	-1.87	12.0	-0.16	DOWN	4.30	-0.15	12.0	-0.01	DOWN	4.26	-0.08	12.0	-0.01	DOWN
	MW-102A	6.8	7.0	-0.2	5.75					5.82					4.45					4.34				
MW-103	MW-103	6.4	13.5	-7.1	2.44	-3.27	5.7	-0.57	DOWN	2.41	-3.31	5.7	-0.58	DOWN	4.30	-0.79	5.7	-0.14	DOWN	4.28	-0.81	5.7	-0.14	DOWN
	MW-103A	6.6	8.0	-1.4	5.71					5.72					5.09					5.09				
MW-105	MW-105	2.5	14.0	-11.5	-0.5	-3.01	9.4	-0.32	DOWN	-0.28	-2.94	9.4	-0.31	DOWN	-1.21	-2.89	9.4	-0.31	DOWN	-1.20	-2.88	9.4	-0.31	DOWN
	MW-105A	5.9	8.0	-2.1	2.51					2.66					1.68					1.68				
MW-106	MW-106	7.4	16.0	-8.6	1.57	0.31	7.7	0.04	UP	1.67	0.32	7.7	0.04	UP	0.46	0.03	7.7	0.00	UP	0.53	0.01	7.7	0.00	UP
	MW-106A	7.1	8.0	-0.9	1.26					1.35					0.43					0.52				
MW-107	MW-107	7.0	18.0	-11.0	4.14	0.68	10.5	0.06	UP	4.12	0.65	10.5	0.06	UP	3.60	0.68	10.5	0.06	UP	3.59	0.65	10.5	0.06	UP
	MW-107A	7.5	8.0	-0.5	3.46					3.47					2.92					2.94				
MW-109	MW-109	4.8	17.5	-12.7	-1.01	0.32	9.6	0.03	UP	-2.65	-4.41	9.6	-0.46	DOWN	-3.59	-2.25	9.6	-0.23	DOWN	-3.94	-4.08	9.6	-0.43	DOWN
	MW-109A	4.9	8.0	-3.1	-1.33					1.76					-1.34					0.14				
MW-111	MW-111B	8.4	8.0	0.4	5.39	-0.03	2.4	-0.01	DOWN	5.40	-0.04	2.4	-0.02	DOWN	4.56	-0.06	2.4	-0.03	DOWN	NM	NA	2.4	NA	NA
	MW-111A	8.3	5.5	2.8	5.42					5.44					4.62					4.58				
MW-112	MW-112B	6.8	7.0	-0.2	5.66	-0.22	0.5	-0.44	DOWN	5.67	-0.32	0.5	-0.64	DOWN	4.77	-0.20	0.5	-0.40	DOWN	4.78	-0.22	0.5	-0.44	DOWN
	MW-112A	6.8	6.5	0.3	5.88					5.99					4.97					5.00				
MW-113	MW-113B	7.0	14.0	-7.0	5.20	-0.14	7.5	-0.02	DOWN	5.17	-0.17	7.5	-0.02	DOWN	4.58	0.02	7.5	0.00	UP	4.57	0.01	7.5	0.00	UP
	MW-113A	7.0	6.5	0.5	5.34					5.34					4.56					4.56				
MW-114	MW-114A	7.8	8.0	-0.2	NM	NA	12.2	NA	NA	NM	NA	12.2	NA	NA	3.25	-0.88	12.2	-0.07	DOWN	4.24	1.16	12.2	0.10	UP
	MW-114B	7.6	20.0	-12.4	NM					NM					4.13					3.08				
MW-115	MW-115A	7.6	8.0	-0.4	NM	NA	12.5	NA	NA	NM	NA	12.5	NA	NA	1.57	-1.91	12.5	-0.15	DOWN	1.59	-1.73	12.5	-0.14	DOWN
	MW-115B	7.6	20.5	-12.9	NM					NM					3.48					3.32				
MW-116	MW-116B	6.3	8.0	-1.7	4.08	-0.35	0.2	-1.75	DOWN	4.16	-0.30	0.2	-1.50	DOWN	3.11	-0.12	0.2	-0.60	DOWN	3.09	-0.14	0.2	-0.70	DOWN
	MW-116A	6.1	8.0	-1.9	4.43					4.46					3.23					3.23				
MW-117	MW-117B	6.3	10.0	-3.7	4.50	-0.06	1.5	-0.04	DOWN	4.52	-0.07	1.5	-0.05	DOWN	3.09	-0.06	1.5	-0.04	DOWN	3.11	-0.04	1.5	-0.03	DOWN
	MW-117A	6.8	9.0	-2.2	4.56					4.59					3.15					3.15				
MW-118	MW-118B	6.8	9.0	-2.2	2.56	-1.22	0.7	-1.74	DOWN	2.75	-1.13	0.7	-1.61	DOWN	1.66	-0.47	0.7	-0.67	DOWN	1.69	-0.47	0.7	-0.67	DOWN
	MW-118A	6.1	9.0	-2.9	3.78					3.88					2.13					2.16				
MW-119	MW-119B	6.2	9.0	-2.8	1.45	0.53	1.2	0.44	UP	1.88	0.65	1.2	0.54	UP	0.40	-0.09	1.2	-0.08	DOWN	0.62	-0.03	1.2	-0.03	DOWN
	MW-119A	6.4	8.0	-1.6	0.92					1.23					0.49					0.65				
MW-120	MW-120B	7.2	12.0	-4.8	1.28	0.15	3.9	0.04	UP	1.37	-0.05	3.9	-0.01	DOWN	0.44	0.12	3.9	0.03	UP	0.49	0.05	3.9	0.01	UP
	MW-120A	7.1	8.0	-0.9	1.13					1.42					0.32					0.44				
MW-121	MW-121A	7.5	8.0	-0.5	NM	NA	8.9	NA	NA	NM	NA	8.9	NA	NA	4.08	-0.04	8.9	0.00	DOWN	4.10	-0.03	8.9	0.00	DOWN
	MW-121B	7.6	17.0	-9.4	NM					NM					4.12					4.13				
Across Aquitard																								
MW-101	MW-101DS	7.1	43.0	-35.9	5.54	0.50	32.9	0.02	UP	5.65	0.70	32.9	0.02	UP	4.71	0.00	32.9	0.00	UP	4.74	0.01	32.9	0.00	UP
	MW-101A	8.5	11.5	-3.0	5.04					4.95					4.71					4.73				
MW-103	MW-103DS	6.5	47.0	-40.5	5.04	2.60	33.4	0.08	UP	5.54	3.13	33.4	0.09	UP	4.32	0.02	33.4	0.00	UP	4.56	0.28	33.4	0.01	UP
	MW-103	6.4	13.5	-7.1	2.44					2.41					4.30					4.28				
MW-107	MW-107DS	7.6	57.0	-49.4	5.23	1.09	38.4	0.03	UP	5.33	1.21	38.4	0.03	UP	4.45	0.85	38.4	0.02	UP	4.59	1.00	38.4	0.03	UP
	MW-107	7.0	18.0	-11.0	4.14					4.12					3.60					3.59				
MW-116	MW-116DS	6.1	24.0	-17.9	4.37	0.29	16.2	0.02	UP	5.14	0.98	16.2	0.06	UP	3.77	0.66	16.2	0.04	UP	4.18	1.09	16.2	0.07	UP
	MW-116B	6.3	8.0	-1.7	4.08					4.16					3.11					3.09				

Notes:  
ft bgs - Feet below ground surface  
ft msl - Feet referenced to mean sea level  
NA - data not available  
NM - not measured

TABLE 3-4  
Calculated Vertical Hydraulic Gradients  
Quanta Resources Superfund Site  
Edgewater, New Jersey

Location	Monitoring Wells	Ground Surface Elevation (ft msl)	Mid-point of Screened Interval (ft bgs)	Elevation of Mid-point of Screened Interval (ft msl)	May 24, 2006										August 14, 2006									
					Low-Tide Conditions (13:11)					High-Tide Conditions (06:59)					Low-Tide Conditions (20:00)					High-Tide Conditions (14:00)				
					Groundwater Elevation (ft msl)	Head Difference (ft)	Elevation Difference (ft)	Vertical Gradient	Vertical Direction	Groundwater Elevation (ft msl)	Head Difference (ft)	Elevation Difference (ft)	Vertical Gradient	Vertical Direction	Groundwater Elevation (ft msl)	Head Difference (ft)	Elevation Difference (ft)	Vertical Gradient	Vertical Direction	Groundwater Elevation (ft msl)	Head Difference (ft)	Elevation Difference (ft)	Vertical Gradient	Vertical Direction
Within Unconfined Aquifer																								
MW-102	MW-102B	6.8	19.0	-12.2	4.69	-0.56	12.0	-0.05	DOWN	4.66	-0.64	12.0	-0.05	DOWN	4.47	-0.55	12.0	-0.05	DOWN	4.45	-0.59	12.0	-0.05	DOWN
	MW-102A	6.8	7.0	-0.2	5.25					5.30					5.02					5.04				
MW-103	MW-103	6.4	13.5	-7.1	4.70	-0.79	5.7	-0.14	DOWN	4.67	-0.82	5.7	-0.14	DOWN	4.39	-0.55	5.7	-0.10	DOWN	4.39	-0.59	5.7	-0.10	DOWN
	MW-103A	6.6	8.0	-1.4	5.49					5.49					4.94					4.98				
MW-105	MW-105	2.5	14.0	-11.5	-0.86	-2.94	9.4	-0.31	DOWN	-0.77	-2.96	9.4	-0.31	DOWN	NM	NA	9.4	NA	NA	NM	NA	9.4	NA	NA
	MW-105A	5.9	8.0	-2.1	2.08					2.19					2.00					2.10				
MW-106	MW-106	7.4	16.0	-8.6	1.12	0.02	7.7	0.00	UP	1.21	0.02	7.7	0.00	UP	1.35	0.02	7.7	0.00	UP	1.29	0.03	7.7	0.00	UP
	MW-106A	7.1	8.0	-0.9	1.10					1.19					1.33					1.26				
MW-107	MW-107	7.0	18.0	-11.0	4.03	0.69	10.5	0.07	UP	3.96	0.63	10.5	0.06	UP	3.86	0.72	10.5	0.07	UP	3.85	0.71	10.5	0.07	UP
	MW-107A	7.5	8.0	-0.5	3.34					3.33					3.14					3.14				
MW-109	MW-109	4.8	17.5	-12.7	-3.14	-1.99	9.6	-0.21	DOWN	-3.57	-4.54	9.6	-0.47	DOWN	-5.41	-4.47	9.6	-0.47	DOWN	-7.91	-8.57	9.6	-0.89	DOWN
	MW-109A	4.9	8.0	-3.1	-1.15					0.97					-0.94					0.66				
MW-111	MW-111B	8.4	8.0	0.4	5.04	-0.02	2.4	-0.01	DOWN	5.05	-0.03	2.4	-0.01	DOWN	4.64	-0.02	2.4	-0.01	DOWN	4.65	0.00	2.4	0.00	UP
	MW-111A	8.3	5.5	2.8	5.06					5.08					4.66					4.65				
MW-112	MW-112B	6.8	7.0	-0.2	5.21	-0.11	0.5	-0.22	DOWN	5.19	-0.15	0.5	-0.30	DOWN	4.95	-0.05	0.5	-0.10	DOWN	4.99	0.00	0.5	0.00	UP
	MW-112A	6.8	6.5	0.3	5.32					5.34					5.00					4.99				
MW-113	MW-113B	7.0	14.0	-7.0	4.91	-0.03	7.5	0.00	DOWN	4.94	-0.01	7.5	0.00	DOWN	4.67	0.00	7.5	0.00	UP	4.66	-0.01	7.5	0.00	DOWN
	MW-113A	7.0	6.5	0.5	4.94					4.95					4.67					4.67				
MW-114	MW-114A	7.8	8.0	-0.2	4.81	0.34	12.2	0.03	UP	4.96	0.34	12.2	0.03	UP	4.27	-0.04	12.2	0.00	DOWN	4.25	-0.06	12.2	0.00	DOWN
	MW-114B	7.6	20.0	-12.4	4.47					4.62					4.31					4.31				
MW-115	MW-115A	7.6	8.0	-0.4	2.00	-1.91	12.5	-0.15	DOWN	2.03	-1.78	12.5	-0.14	DOWN	3.76	1.92	12.5	0.15	UP	3.71	1.86	12.5	0.15	UP
	MW-115B	7.6	20.5	-12.9	3.91					3.81					1.84					1.85				
MW-116	MW-116B	6.3	8.0	-1.7	3.78	-0.26	0.2	-1.30	DOWN	3.96	-0.05	0.2	-0.25	DOWN	3.41	-0.25	0.2	-1.25	DOWN	2.74	-0.99	0.2	-4.95	DOWN
	MW-116A	6.1	8.0	-1.9	4.04					4.01					3.66					3.73				
MW-117	MW-117B	6.3	10.0	-3.7	4.03	-0.04	1.5	-0.03	DOWN	4.01	-0.11	1.5	-0.07	DOWN	3.67	-0.02	1.5	-0.01	DOWN	3.71	-0.06	1.5	-0.04	DOWN
	MW-117A	6.8	9.0	-2.2	4.07					4.12					3.69					3.77				
MW-118	MW-118B	6.8	9.0	-2.2	2.07	1.66	0.7	2.37	UP	2.26	-0.18	0.7	-0.26	DOWN	2.14	-1.10	0.7	-1.57	DOWN	2.15	-1.14	0.7	-1.63	DOWN
	MW-118A	6.1	9.0	-2.9	0.41					2.44					3.24					3.29				
MW-119	MW-119B	6.2	9.0	-2.8	1.02	-0.11	1.2	-0.09	DOWN	1.31	-0.02	1.2	-0.02	DOWN	1.50	NA	1.2	NA	NA	1.39	NA	1.2	NA	NA
	MW-119A	6.4	8.0	-1.6	1.13					1.33					NM					NM				
MW-120	MW-120B	7.2	12.0	-4.8	1.10	0.14	3.9	0.04	UP	1.20	-0.04	3.9	-0.01	DOWN	1.35	0.12	3.9	0.03	UP	1.26	0.08	3.9	0.02	UP
	MW-120A	7.1	8.0	-0.9	0.96					1.24					1.23					1.18				
MW-121	MW-121A	7.5	8.0	-0.5	4.51	0.01	8.9	0.00	UP	4.55	0.07	8.9	0.01	UP	4.26	0.00	8.9	0.00	UP	4.25	0.04	8.9	0.00	UP
	MW-121B	7.6	17.0	-9.4	4.50					4.48					4.26					4.21				
Across Aquitard																								
MW-101	MW-101DS	7.1	43.0	-35.9	5.16	0.00	32.9	0.00	UP	5.24	0.06	32.9	0.00	UP	4.99	0.00	32.9	0.00	UP	5.04	0.05	32.9	0.00	UP
	MW-101A	8.5	11.5	-3.0	5.16					5.18					4.99					4.99				
MW-103	MW-103DS	6.5	47.0	-40.5	4.74	0.04	33.4	0.00	UP	5.16	0.49	33.4	0.01	UP	4.61	0.22	33.4	0.01	UP	4.92	0.53	33.4	0.02	UP
	MW-103	6.4	13.5	-7.1	4.70					4.67					4.39					4.39				
MW-107	MW-107DS	7.6	57.0	-49.4	5.05	1.02	38.4	0.03	UP	5.12	1.16	38.4	0.03	UP	4.55	0.69	38.4	0.02	UP	4.52	0.67	38.4	0.02	UP
	MW-107	7.0	18.0	-11.0	4.03					3.96					3.86					3.85				
MW-116	MW-116DS	6.1	24.0	-17.9	4.12	0.34	16.2	0.02	UP	4.81	0.85	16.2	0.05	UP	4.06	0.65	16.2	0.04	UP	4.69	1.95	16.2	0.12	UP
	MW-116B	6.3	8.0	-1.7	3.78					3.96					3.41					2.74				

Notes:  
ft bgs - Feet below ground surface  
ft msl - Feet referenced to mean sea level  
NA - data not available  
NM - not measured

TABLE 4-1

NAPL Measurements

Quanta Resources Superfund Site, OU1

Edgewater, New Jersey

Hydro-stratigraphic Unit	Well	X-coordinate	Y-coordinate	Measuring Point Elevation (ft msl)	NAPL Thickness (ft)				
					Jun-99*	Dec-05	Mar-06	May-06	Aug-06
SHALLOW (UNCONFINED) OVERBURDEN	MW-101A	719022.06	632767.64	10.63	NM	NM	ND	ND	ND
	MW-102A	718774.51	632942.16	9.69	ND	NM	4.0	5.0	6.50
	MW-103A	718607.48	633205.75	10.03	NM	NM	ND	ND	ND
	MW-105A	718414.17	633552.17	8.20	ND	NM	1.0 LNAPL	ND	0.08 LNAPL
	MW-106A	718187.85	633438.50	6.65	NM	NM	ND	ND	ND
	MW-107A	718371.31	632973.74	7.04	NM	NM	ND	ND	ND
	MW-108	718580.00	632735.00	7.17	NM	NM	NM	ND	ND
	MW-109A	718064.11	633349.26	4.56	NM	NM	ND	ND	ND
	MW-111A	719195.22	632596.28	7.98	NM	NM	ND	ND	ND
	MW-112A	718954.83	633038.93	10.01	NM	NM	ND	0.20	0.21
	MW-113A	718887.05	633231.50	10.20	NM	NM	ND	ND	ND
	MW-114A	718640.09	633028.45	7.41	NM	NM	ND	ND	ND
	MW-115A	718206.33	632949.42	7.14	NM	NM	ND	ND	ND
	MW-116A	718564.88	633607.66	9.45	NM	NM	ND	0.16	0.58
	MW-117A	718495.51	633575.22	9.37	NM	NM	0.25	2.0	0.17
	MW-118A	718454.55	633573.47	9.00	NM	NM	ND	ND	ND
	MW-119A	718343.86	633523.03	6.00	NM	NM	ND	ND	NM
	MW-120A	718212.64	633495.32	6.83	NM	NM	ND	ND	ND
	MW-121A	718455.01	633276.03	7.13	NM	NM	ND	ND	ND
	MW-122A	718339.41	632953.13	7.24	NM	NM	ND	ND	ND
	MW-A-2*	719104.51	633164.73	17.29	NM	NM	ND	ND	ND
	MW-B*	718860.97	633388.94	15.40	NM	NM	ND	ND	ND
	MW-C*	718703.23	633651.85	14.75	NM	NM	ND	ND	ND
	MW-D*	719033.11	633512.16	15.27	NM	NM	ND	ND	ND
	MW-F*	718804.86	633811.88	11.29	NM	NM	ND	ND	ND
	MW-G*	719310.72	633353.87	13.91	NM	NM	ND	ND	ND
	MW-I*	719078.27	633801.54	19.13	NM	NM	ND	ND	ND
	MW-J*	718920.09	634110.90	16.09	NM	NM	ND	ND	ND
	MW-L*	719301.42	632947.29	15.05	NM	NM	ND	ND	ND
	MW-26	718129.00	632410.41	9.57	NM	NM	NM	NM	ND
	MW-29	718363.77	633048.64	7.09	NM	NM	NM	NM	ND
	MW-31	718314.63	632901.03	7.10	NM	NM	NM	NM	ND
	MW-32	718128.49	632889.70	6.30	NM	NM	NM	NM	ND
	MW-36 (LB)	718126.26	632759.61	7.37	NM	NM	NM	NM	ND
	MW-7	718228.96	633273.24	6.94	NM	NM	NM	NM	NM
	MW-25	717917.29	633037.60	7.09	NM	NM	NM	NM	ND

TABLE 4-1

NAPL Measurements

Quanta Resources Superfund Site, OU1

Edgewater, New Jersey

Hydro-stratigraphic Unit	Well	X-coordinate	Y-coordinate	Measuring Point Elevation (ft msl)	NAPL Thickness (ft)				
					Jun-99*	Dec-05	Mar-06	May-06	Aug-06
SHALLOW (UNCONFINED) OVERBURDEN	MW-30	718116.46	633203.41	6.27	NM	NM	NM	NM	ND
	ACMW-1	719343.72	633428.46	11.29	NM	NM	NM	NM	NM
	ACMW-3	719119.21	633543.67	14.34	NM	NM	NM	NM	NM
	MW-20	718848.78	633445.86	15.05	NM	NM	NM	NM	NM
	MW-22A	719250.48	633323.31	10.35	NM	NM	NM	NM	NM
	MW-36 (EE)	719166.24	633686.59	14.14	NM	NM	NM	NM	NM
	MW-E	718829.23	633581.44	14.96	NM	NM	NM	NM	NM
	MW-K	719274.51	633815.30	13.92	NM	NM	NM	NM	NM
	MW-M	719602.40	633140.38	15.56	NM	NM	NM	NM	NM
	MW-N-2	719157.71	633037.37	11.42	NM	NM	NM	NM	NM
	MW-O	718746.51	633563.10	15.51	NM	NM	NM	NM	NM
DEEP UNCONFINED	MW-102	718774.26	632941.80	9.24	Sheen, evidence of NAPL	NM	0.2	2.10	2.17
	MW-102B	718766.25	632931.53	9.61	ND	NM	1.5	0.33	0.25
	MW-103	718633.11	633224.04	8.57	Evidence of NAPL	NM	1.0	1.0	ND
	MW-104/ MW-104R	718519.79	633611.94	9.11	4.0	NM	0.2	0.16	ND
	MW-105	718420.92	633568.90	5.03	0.08	NM	5.5	ND	NM
	MW-106	718216.29	633448.63	7.13	Soil staining, odors	NM	ND	ND	ND
	MW-107	718396.33	633001.00	6.84	Soil staining, odors	NM	1.4	1.10	ND
	MW-109	718060.47	633348.35	4.49	NM	NM	ND	ND	ND
	MW-111B	719186.92	632597.85	7.85	NM	NM	ND	ND	ND
	MW-112B	718965.16	633046.35	9.60	NM	NM	1.8	2.0	3.00
	MW-113B	718891.63	633233.93	9.94	NM	NM	ND	ND	ND
	MW-113C	718899.82	633232.35	9.80	NM	NM	ND	ND	ND
	MW-114B	718646.47	633018.97	7.24	NM	NM	ND	ND	ND
	MW-115B	718209.64	632951.57	6.70	NM	NM	ND	ND	ND
	MW-116B	718564.00	633614.00	8.69	NM	NM	6.5	3.5	11.50
	MW-117B	718490.38	633577.94	9.04	NM	NM	ND	ND	ND
	MW-118B	718443.68	633572.98	9.40	NM	NM	0.08	0.25	0.25
	MW-119B	718355.51	633526.26	5.68	NM	NM	ND	ND	ND
	MW-120B	718223.61	633484.97	6.78	NM	NM	ND	ND	ND
	MW-121B	718457.53	633272.15	7.16	NM	NM	ND	ND	ND

**TABLE 4-1**

NAPL Measurements

*Quanta Resources Superfund Site, OU1**Edgewater, New Jersey*

Hydro-stratigraphic Unit	Well	X-coordinate	Y-coordinate	Measuring Point Elevation (ft msl)	NAPL Thickness (ft)				
					Jun-99*	Dec-05	Mar-06	May-06	Aug-06
DEEP SAND (CONFINED)	MW-101DS	719004.98	632748.11	10.45	NM	NM	ND	ND	ND
	MW-103DS	718609.96	633208.63	10.13	NM	NM	ND	ND	ND
	MW-107DS	718369.21	632986.22	6.82	NM	NM	ND	ND	ND
	MW-116DS	718555.99	633613.65	9.18	NM	NM	ND	ND	ND
	MW-N-1	719148.72	633040.28	12.00	NM	NM	NM	NM	NM
	MW-A-1	719111.78	633144.36	16.06	NM	NM	ND	ND	ND
STAFF GAUGE	TGS-1	718038.01	633937.21	12.58	NM	ND	ND	ND	NM
UNKNOWN	DMW-2	719172.49	633688.59	14.14	NM	NM	NM	NM	NM
BEDROCK	MW-N-3	719133.67	633089.76	13.34	NM	NM	NM	NM	NM

## Notes:

\*Measurements collected during Removal Site Investigation activities (GeoSyntec, 2000 and 2001) using an interface probe

Measurements shown are of dense non-aqueous phase liquid (DNAPL) unless noted as light NAPL (LNAPL).

ft msl - Feet referenced to mean sea level, NAVD 88

NM = not measured

ND = not detected

**TABLE 4-2**

Summary of NAPL Fingerprinting and Physical Parameters

*Quanta Resources Site, OU1**Edgewater, New Jersey*

Parameter	Method	Units	MW-102	MW-103	MW-104	MW-105	SEEP-1	SEEP-2	MW-102A	MW-105	MW-112B	MW-116B	MW-107	MW-7
Type of Material**			Coal Tar	Coal Tar	Coal Tar	Coal Tar	Weathered Coal Tar	Weathered Coal Tar	Coal Tar	Coal Tar	Coal Tar	Coal Tar	Coal Tar	Unknown Hydrocarbon
Kinematic Viscosity @ 122 °F	ASTM-D445	cSt	---	---	---	---	---	---	14.31	181.6	61.23	27.44	3.49	4.93
Viscosity SFS @ 122 °F	ASTM-D2161	Second	---	---	---	---	---	---	N/A	86.4	31.1	N/A	N/A	N/A
Interfacial Tension	ASTM-D971	Dynes/cm <sup>2</sup>	---	---	---	---	---	---	25.0	30.2	27.5	18.0	8.2	25.9
API Gravity @ 60 °F	ASTM-D4052	°API	---	---	---	---	---	---	-2.32	NM	-4.81	-6.2	3.15	29.8
Density @ 60 °F	ASTM-D4052	kg/m <sup>3</sup>	---	---	---	---	---	---	N/A	NM	N/A	N/A	1049.8	876.8
Specific Gravity @ 60 °F	ASTM-D4052	none	---	---	---	---	---	---	1.0951	NM	1.1168	1.1293	1.0505	0.8772

## Notes:

\*Sampling conducted in 2003 was performed by Parsons. The type of material was determined, but the physical parameters of the samples were not analyzed.

\*\*Type of Material is based on chemical analyses involving GC/FID fingerprinting (EPA Methods 8100 modified) and EPA Method 8260 and 8270 (for VOCs, SVOCs and petroleum biomarkers). An evaluation of diagnostic ratios and the comparison of these results to the in-house library at META Environmental, Inc. of Watertown, MA was also used to determine material type.

Coal Tar: coal carbonization tars, coke oven tars and creosotes

ASTM - ASTM International

cSt - centistoke

SFS - Saybolt Furol Second

cm<sup>2</sup> - square centimeters

NM - American Petroleum Institute (API) Gravity reading was not measured because sample was thick with what appeared to be a sediment-like material.

N/A - Not applicable



**TABLE 4-3**  
Correlation of TarGOST® Results with Boring Logs: Evidence for Presence of NAPL at 50% RE  
*Quanta Resources Superfund Site, OU1*  
*Edgewater, New Jersey*

TarGOST® Location	Adjacent and/or Collocated Borings		%RE Range	Max. Signal (%RE)	Depth of Max Signal (ft bgs)	Total TarGOST® Boring Depth (ft)	Pilot Hole Depth (ft bgs)	Associated Analytical Soil Results for Select Compounds (mg/kg)	Description of Tar/ Product Observed	Comments
	Boring ID	Visual Description(s)								
TL10-03.5	GZA-19, LB-1, TL10 3.5	TL10 3.5: Peat, sulfur smell	50-75	53.8	11.0	32.1	5	Benzo(a)pyrene: 3': 31.1 11': ND 36': 0.093		False Positive
TL11-03.5	LB-19, SB-16	No product in LB-19, ICS and product at 16.5 - 20.6 in SB-16	50-75	58.8	23.9	30.1	5		Medium and high viscosity liquid	
TL09-03.5	MW-30, MW-109, MW-109A, B-2	B-2: Trace pitch material at 3'	25-50	44.4	13.6	27.1	5			
TL09-05.5	GZA-20, GZA-21, GZA-22, GZA-23, GZA-24, GZA-25, GZA-26, GZA-50, MW-115A, MW-115B, MW- 32, LB-18, LB-23		25-50	29.3	8.3	22.1	5			
TL10-04.5	SB-16	ICS and product at 16.5 - 20.6	50-75	63.3	19.2	27.2	5		Medium and high viscosity liquid	
TL10-05.5	LB-3, LB-4, LB-24, LB-25, LB-26, LB-27, LB-28, MW-31, MW-122A, B-21	LB-3: Sheen/odor at 4' LB-26: Black fill at 2-13' MW-31: Black coal material at 8' MW-122A: SCF at 7'	75-100	95.5	6.5	26.0	5			
TL11-02.5	GZA-19, GZA-28, MW-7, LB-1		25-50	27.4	9.4	24.1	5			
TL11-04.5	LB-2, SB-16, GZA-49, MW-29, MW-6		300+	752.4	20.2	27.0	5			
TL11-05.5	MW-6, MW-107, MW-107A, MW- 107DS	MW-107: Low viscosity DNAPL	100-200	133.1	4.3	22.3	5			
TL11-06.5	SB-18	No product - air rotary to 13'	50-75	75.2	10.8	25.1	5			
TL11-07.5	SB-17, GZA-48, MW-5, MW-27, MW- 37D, MW-108, TL11 7.5	TL 11 07.5: ICS at 10-15', product staining SB-17: product at 7-10'	75-100	133.0	14.6	26.1	5		Low viscosity liquid	
TL11-08.5	B-200, B-201, B-202, B-203, B-204, B-205, B-206, B-207, B-208, B-209	B-207: Coal tar	50-75/ 75-100	65.1	12.7	29.1	7			
TL12-03.5			100-200	128.9	21.4	24.0	7			
TL12-04.5	GZA-47	Oil, coal ash, pitch at 4-7'	300+	912.9	6.1	28.6	6			
TL12-05.5	GZA-47		100-200	198.9	23.0	28.1	5			
TL12-06.5			50-75	69.4	7.1	26.1	5			
TL12-07.5			50-75	79.4	12.4	27.0	5			
TL12-08.5	B-214	No product, not much data	100-200/ 200-300	252.8	28.7	37.0	5			
TL12-09	B-213, B-212, B-217, B-219	No coal tar	75-100	66.8	15.3	29.3	11			
TL12-10.75	B-210, B-211, B-205, B-206, B-207, B-215, B-216	TL12 10.75: Black product/ICS at 7 to 27' B-207: Coal tar	100-200/ 200-300	248.6	14.4	32.2	4		Medium viscosity liquid	
TL12-11.25	B-215, B-216		50-75	81.2	12.9	34.1	2			

**TABLE 4-3**  
Correlation of TarGOST® Results with Boring Logs: Evidence for Presence of NAPL at 50% RE  
*Quanta Resources Superfund Site, OU1*  
*Edgewater, New Jersey*

TarGOST® Location	Adjacent and/or Collocated Borings		%RE Range	Max. Signal (%RE)	Depth of Max Signal (ft bgs)	Total TarGOST® Boring Depth (ft)	Pilot Hole Depth (ft bgs)	Associated Analytical Soil Results for Select Compounds (mg/kg)	Description of Tar/ Product Observed	Comments
	Boring ID	Visual Description(s)								
TL12-11.75	B-215, B-216, TL12 11.75	TL12.5 11.75: Peat, no product	25-50	50.7	12.4	22.0	4	Benzene at 18': ND (No Suggestions) at 18': 0.0552 J Naphthalene at 18': 0.215		False Positive
TL12.5-11.25	B-220, B-221, B-222		50-75	58.5	17.0	29.1	3			
TL12.5-11.75	B-220, B-221, B-222, TL12.5 11.75	ICS at 0-5', peat	100-200	154.0	21.7	22.2	3			False Positive
TL12.5-12.25	B-220, B-221, B-222, TL12.5 12.25	TL12.5 12.25: Peat, no product	50-75	106.8	19.1	21.6	4			False Positive
TL13-02	SB-1	SB-1: Trace black product at 15'	25-50	49.1	10.8	22.1	5	SB-1 at 14 to 15' Benzene: 4.5 (No Suggestions): 24 Naphthalene: 890	Black product	
TL13-03	MW-121A, MW-121B	Staining at 21-24'	50-75	88.8	26.8	30.0	5		Low viscosity liquid	
TL13-04	MW-121A, MW-121B	No product (low recovery) Staining at 19-24'	300+	441.4	19.4	26.2	5		Low/medium viscosity liquid	
TL13-05	SB-4	SB-4: Low viscosity product and ICS at 8-10'	300+	933.1	8.4	27.1	5		Low viscosity liquid	
TL13-06	MW114A, MW114B	SCF, staining 8.5-10.5'	25-50	53.7	24.6	26.1	5		Low/medium viscosity liquid	
TL13-07	MW114A, MW114B	SCF, staining 8.5-10.5'	300+	622.2	9.5	26.2	5		Low/medium viscosity liquid	
TL13-08	SB-8	Black product from 8-9'	25-50	49.5	9.7	26.1	5	SB-8 at 8.5 to 9' Benzene: 29 Benzo(a)pyrene: 460 Naphthalene: 5800	Black product	
TL13-09	B-223, B-224	B-224: Coal tar	75-100	119.1	14.2	26.1	5			
TL13-11.25	SB-25	Sheen, product odor at 5', some cinders	25-50	68.5	5.0	32.1	3			
TL13.5-01	MW-119A, MW-119B	Black product in pore space and prominent ICS at 2-10'	50-75	79.4	10.4	16.1	5		Black product, low/ medium viscosity liquid	
TL13.5-11.25	SB-25	Cinder, sheen at 5'	25-50	32.8	7.9	26.0	5	Benzene: 1': ND, 8': 3.88, Benzo(a)pyrene: 1': 37.9, 8': 205 Naphthalene: 1': 0.5, 8': 2600		
TL14-01	MW-105, MW-105A, MW-118, MW-118A	MW-105: Product staining at 7.5 to 9', soft plastic solid tar at 3.5 -4.0' MW-118: SCF, black sheen, odor at 4'	200-300	276.1	6.2	25.1	4		Low/medium viscosity liquid; soft, plastic solid tar	
TL14-02	SB-2	Viscous tar at 1 to 12', black product at 10.8 -12'	100-200	102.1	4.5	27.1	4		Medium viscosity liquid & soft plastic solid	
TL14-03			25-50	25.1	3.2	27.0	3			
TL14-04			100-200	126.1	18.0	21.0	4			
TL14-05	MW-103, MW-103A, MW-103DS	SCF, black product staining, sheen at 7-13' and thick black product stain at 18-22'	200-300	234.2	21.1	23.1	4		Low/medium viscosity liquid	
TL14-06	SB-6	Product intermittent 1.2 to 21.7'	75-100	99.5	20.7	22.0	4.5		Medium viscosity liquid	

**TABLE 4-3**  
Correlation of TarGOST® Results with Boring Logs: Evidence for Presence of NAPL at 50% RE  
*Quanta Resources Superfund Site, OU1*  
*Edgewater, New Jersey*

TarGOST® Location	Adjacent and/or Collocated Borings		%RE Range	Max. Signal (%RE)	Depth of Max Signal (ft bgs)	Total TarGOST® Boring Depth (ft)	Pilot Hole Depth (ft bgs)	Associated Analytical Soil Results for Select Compounds (mg/kg)	Description of Tar/ Product Observed	Comments
	Boring ID	Visual Description(s)								
TL14-07	SB-6	Product intermittent 1.2 to 21.7'	75-100	87.6	5.7	22.3	4		Medium viscosity liquid	
TL14-08	MW-102, MW-102A, MW-102B, B-228, B-229	MW-102B: Dense product stain at 3 to 22'	100-200	133.7	6.8	29.3	5		Low/medium viscosity liquid	
TL14-09	B-225, B-226, B-227, TL14 09 B-230, B-231, B-232	TL14 09: Viscous black product at 7' and solid tar to 16'	300+	335.3	7.5	22.2	5		Medium viscosity liquid & plastic solid	
TL14-10.75	B-233, B-234, B-235, SB-10	SB-10: Product stain at 2-6', sulfur odor/peat at 20'	50-75	59.7	14.9	29.3	5	Benzene: 2': 13.9, 15': 17.7 Benzo(a)pyrene:2': 181, 15': 177 Naphthalene: 2': 2500, 15': 2600	Low/medium viscosity liquid	
TL14-11.25	SB-13, SB-23	SB-23: Solid plastic tar at 3.5 to 11'	25-50	34.6	11.0	23.7	5	SB-23 Benzene: 3': 3.74, 11': 2.75 Benzo(a)pyrene: 3': 308, 11': 455 Naphthalene: 3': 4300, 11': 396	Plastic solid	
TL14.5-11.25	SB-13, TL 14.5-11.25	Brittle solid at 6'	25-50	33.6	8.9	26.0	5		Brittle solid	
TL15-01	MW-104, MW-104A, MW-116A, MW-116B, MW116D, MW-117A, MW-117B	MW-104B: Stained, odor/ soft tar fill at 7 to 9' MW-116A: Product at 3 to 4' MW-116B: Pitch tar at 4 to 6'	50-75	64.7	6.4	25.1	5		Low/ medium viscosity liquid; soft, plastic solid; hard pitch solid	
TL15-02	SB-3	HPT at 5' and 9 to 11'	50-75	50.6	8.1	22.0	3		HPT	
TL15-03	SB-3	HPT at 1 to 5' and 9 to 11' and soft plastic tar at 1 to 5'	100-200	166.4	3.3	27.3	3		Soft, plastic solid; hard pitch solid	
TL15-04			50-75	59.7	16.3	22.1	5			
TL15-05	SB-5	SCF at 3 to 5' and 8 to 22', black product 13.5 to 20'	300+	388.0	19.9	24.1	5		Low/medium viscosity liquid	
TL15-06	SB-6	Black product and odor intermittent to 20'	200-300	284.4	20.9	22.2	7		Low/medium viscosity liquid	
TL15-07	SB-7		75-100	86.8	9.5	22.2	9			
TL15-08	SB-9	Petroleum product odor, sheen, product at 20 to 24'	100-200	133.3	7.5	29.0	5		Low/medium viscosity liquid	
TL15-09	B-236, B-237, B-238, TL15 09	TL15 09: ICS/ Plastic tar at 5 to 15'	75-100	75.9	8.1	27.0	0	Benzene at 14': 12.6 Benzo(a)pyrene at 14': 226 Fluoranthene at 14': 524	Plastic solid tar	
TL15-10.75	MW-101A, SB-11, MW-101DS, TL15 10.75	TL15 10.75: Black product at 5'	50-75	54.3	0.0	27.1	5		Black product; low/ medium viscosity liquid	
TL15-11.25	SB-24, (B-236, B-237, B-238, B-239, B-240, B-241)	Cinders at 4.5'	0-25	15.8	1.1	24.3	5	Benzo(a)pyrene at 1': 38.9		
TL16-01			0-25	22.2	3.0	15.0	3			
TL16-02			100-200	111.7	10.0	14.3	3			
TL16-03			50-75	68.6	20.4	22.0	18.5			
TL16-04	MW-21		50-75	50.9	28.2	32.1	18.5			
TL16-05	MW-1, SS-13A	SS-13A: Product	50-75	54.9	24.7	30.4	13			
TL16-06	MW-113A, MW-113B, MW-113C, SB-7, TL16 06	TL 16 06: ICS at 20' MW-113B: Air rotary to 8'	50-75	67.5	5.8	14.8	3	Benzo(a)pyrene at 1': 200 Benzo(a)pyrene at 24': 26		

**TABLE 4-3**  
Correlation of TarGOST® Results with Boring Logs: Evidence for Presence of NAPL at 50% RE  
*Quanta Resources Superfund Site, OU1*  
*Edgewater, New Jersey*

TarGOST® Location	Adjacent and/or Collocated Borings		%RE Range	Max. Signal (%RE)	Depth of Max Signal (ft bgs)	Total TarGOST® Boring Depth (ft)	Pilot Hole Depth (ft bgs)	Associated Analytical Soil Results for Select Compounds (mg/kg)	Description of Tar/ Product Observed	Comments
	Boring ID	Visual Description(s)								
TL16-07	TL16 07	TL16 07: Some viscous product in pore space at 5'	50-75	56.4	8.5	18.2	6.5	Naphthalene: 1': 279, 9': 23.7 Benzo(a)pyrene: 1': 941, 9': 59.6	Viscous product/pore space	
TL16-08	MW-112A, MW-112B	Product from 4.8 to 8.9', DNAPL in MW-112B	25-50	37.2	10.5	31.1	3			False Negative
TL16-09	B-242, B-243, B-244, TL16 09	TL16 09: ICS and low viscosity product at 2'	75-100	80.3	0.5	24.0	3		Low viscosity liquid	
TL16.5-03	SS-18A, SS-18B, SS-18C, SS-18C2, SS-19A, SS-20A, MW-O	SS-18A: staining at 16 to 17'	50-75	51.4	7.4	10.0	5			
TL16.5-04	SS-14A, SS-14.5A, SS-15A, SS-15B, SS-15C, P-1, MW-31, MW-31C	SS-14: Black staining with sheen at 13', stained black at 17'	25-50	36.5	13.4	26.0	13			
TL16.5-05	SS-13A, SS-13B, SS-13C, SS-13D, SS-13E, (MW-B)		0-25	5.6	13.1	28.6	13			
TL17-01			300+	335.9	19.2	26.2	13			
TL17-02	SS-20C, MW-C, MW-2, SS-21A, SS-21B, SS-22A, SS-23A	SS-20C: Sheen and petroleum odor	0-25	16.3	18.2	19.1	13.5			
TL17-03	SS-19.5A, SS-19.5A2, SS-20B, SS-20C		0-25	12.2	0.0	11.4	3			
TL17-04	SS-14.5A, MW-20		0-25	11.3	13.7	14.7	13			
TL17-05	SS-13E, MW-B, TL17 05	TL17 05: No product or staining	25-50	9.7	10.8	26.0	12.5			
TL17.5 01	SS-25A		0-25	12.7	2.3	10.5				
TL17.5-02	SS-23A, SS-24A, SS-24B, SS-25A	SS21A: Product at 20'	300+	414.6	19.1	19.3	15			
TL17-06	MW-113A, MW-113B, MW-113C, TL17 06	MW-113 and TL17 06: No product or staining	25-50	47.2	1.1	17.3	4			
TL17-07	TL17 07	Purple hue, no product	50-75	50.8	9.9	24.1	5			False Positive
TL17-08	TL17 08	Solid plastic tar 0 to 2', sulfur odor at 10'	25-50	36.9	9.9	24.0	3	Benzo(a)pyrene: 1': 305, 4': 0.723 Naphthalene: 1': 57.9, 4': 0.265		
TL17.5-03	SS-19A, SS-19A2, SS-19B, SS-19B2, SS-21C		0-25	16.3	4.2	11.4	12			
TL18-0.5			0-25	9.9	16.3	28.1	12			
TL18-01	SS-25A, SS-25B, SS-26A		0-25	15.9	7.9	24.1	0			
TL18 02	SS-22B, SS-23B		0-25	13.6	21.3	22.3				

**TABLE 4-3**  
Correlation of TarGOST® Results with Boring Logs: Evidence for Presence of NAPL at 50% RE  
*Quanta Resources Superfund Site, OU1*  
*Edgewater, New Jersey*

TarGOST® Location	Adjacent and/or Collocated Borings		%RE Range	Max. Signal (%RE)	Depth of Max Signal (ft bgs)	Total TarGOST® Boring Depth (ft)	Pilot Hole Depth (ft bgs)	Associated Analytical Soil Results for Select Compounds (mg/kg)	Description of Tar/ Product Observed	Comments
	Boring ID	Visual Description(s)								
TL18-03	SS-18D, SS-18E, SS-19C, SS-19D, SS-19E, SS-19.5B, SS- 19.5C, SS-10.5C1, SS-10.5E	SS-19.5B: Trace product 11 ft bgs SS19.5C1: Product noted 14-14.5 ft bgs	0-25	10.7	13.2	13.6	12			
TL18-01.5	SS-24C, SS-24C, SS-25C		0-25	7.7	5.9	12.7	3			
TL18.5-0.5	TL18.5 0.5	TL18.5 0.5: Black product,	50-75	56.3	14.5	32.2	11	16'/29.5' - Benzene: 16': 0.85, 29.5':7.3 Naphthalene: 16':4120, 29.5':129 Benzo(a)pyrene: 16': 1110 29.5': 2.43 2,4-Dimethyphenol: 16': ND, 29.5': 1.43	Black product; low/ medium viscosity liquid	
TL18.5-01	SS-26B, MW-F		0-25	11.5	29.3	32.0	11.5			
TL18.5-01.5	TL18.5 01.5		75-100	87.1	24.5	29.2	3			False Positive
TL19-0.5	MW-F	Air rotary to 12', ICS at 25'	0-25	23.6	31.0	34.1	11	Benzo(a)pyrene at 29': 2.28		
TL19 01			0-25	14.8	19.2	32.1				
TL19.5-0.5	TL19.5 0.5	Some ICS	25-50	37.2	28.6	28.6	11			

Notes:

\*Analytical data included only if major constituents exceed 2004 proposed NJ DEP Soil Cleanup Criteria.

%RE - TarGOST® response measured as percent of a reference emitter

DNAPL - Dense Non-Aqueous Phase Liquid

ft bgs - feet below ground surface

HPT - Hard Pitch Tar

ICS - Incandescent Sheen

mg/kg - milligrams per kilogram

SCF - Slag, Cinder, Fill

Table 4-4  
Cinder/Ash/Coal/Slag and Reddish-Purple Soil Observations and Sampling Summary  
Characterization of Cinder/ Ash and Reddish-Purple Soils  
Quanta Resources Superfund Site, OU1  
Edgewater, New Jersey

Location	Property	Consultant Reference	Total Boring Depth (ft)	Visually Observed Cinder/ Coal/ Ash/ Slag/ Reddish-Purple Interval			Field Log Description	Cinder/ Coal/ Ash/ Slag Sampled	Reddish-Purple Color Present	Sampled Interval (ft bgs)	Soil Sampling Analytical Summary																						
				Interval Top (ft bgs)	Interval Bottom (ft bgs)	Thickness (ft)					PAHs (via 8270)	6020	9014	E160.3	E350.2	SW6010	SW7196	SW7471	SW8081	SW8082	SW8260	SW8270	SW9012	SW9045	SW9060 (TOC)	SPLP, SW6010	SPLP, SW7470	SPLP, SW8082	SPLP, SW8260	SPLP, SW8270	ASTM D1498	ASTM D422	ASTM D4318
MW-103A	Quanta	1	14	0.16	1.4	1.2	gravel w/ cinder, v. dark gray																										
MW-103DS	Quanta	1	54	4.7	6.0	1.3	sandy silt w/ cinder/slag, black, soft, obvious product odor	X		5.0-6.0				X		X	X		X	X	X	X											
MW-104R	Quanta	1	13	0.0	0.5	0.5	black slag/cinder material																										
MW-105A	Quanta	1	18	3.5	6.0	2.5	gravel with crushed brick and black cinder/slag w/in sub-angular gravel	X		3.4-3.6				X		X	X			X	X	X											
								X		3.6-3.9				X		X	X			X	X	X											
MW-112B	Quanta	1	17	4.0	4.2	0.2	intermixed gravel and cinder/slag, v. dark gray																										
MW-116B	Quanta	1	15	0.0	7.0	7.0	organic silt w/ brick, cobbles, and cinder/slag/fill; various colors	X		0.0-0.16				X		X	X			X	X	X											
	Quanta	1	15	0.0	7.0	7.0	organic silt w/ brick, cobbles, and cinder/slag/fill; various colors	X		1.75-2.0				X		X	X			X	X	X											
	Quanta	1	15	0.0	7.0	7.0	organic silt w/ brick, cobbles, and cinder/slag/fill; various colors	X		4.5-5.0				X		X	X			X	X	X											
MW-116DS	Quanta	1	29	2.5	3.0	0.5	gravel intermixed w/ fine sand and cinder/slag/fill; black																										
MW-117A	Quanta	1	17	0.0	10.0	10.0	fine/med silty sand w/cinder/slag; various colors, obvious naphthalene odor																										
MW-117B	Quanta	1	18	0.0	14.0	14.0	fine/med silty sand w/ cinder/slag, naphthalene odor, sheen	X		0.0-0.16				X		X	X			X	X	X											
	Quanta	1	18	0.0	14.0	14.0	fine/med silty sand w/ cinder/slag, naphthalene odor, sheen	X		4.0-5.5				X		X	X			X	X	X											
MW-118A	Quanta	1	15	3.0	13.0	10.0	gravel and fine/med sand w/ cinder/slag; black, obvious product odor																										
SB-02	Quanta	1	30	0.0	10.0	10.0	med/coarse sand w/ crushed brick, wood, cinder/slag/fill, some soft tar; various colors	X		0.0-0.16				X		X	X			X	X	X											
	Quanta	1	30	0.0	10.0	10.0	med/coarse sand w/ crushed brick, wood, cinder/slag/fill, some soft tar; various colors	X		9.5-10.0				X		X	X			X	X	X											
SB-03	Quanta	1	22	1.0	5.0	4.0	gravel w/ cinder/slag, tar/fill; black, dry, soft and plastic; strong odor	X		0.0-0.16				X		X	X			X	X	X											
	Quanta	1	22	1.0	5.0	4.0	gravel w/ cinder/slag, tar/fill; black, dry, soft and plastic; strong odor	X		3.5-4.0				X		X	X			X	X	X										X	
SB-05	Quanta	1	24	3.75	5.0	1.3	silty sand w/ angular gravel, cinder/slag/fill; black staining, various colors, obvious naph odor																										
SB-06	Quanta	1	24	1.2	2.0	0.8	brick, viscous tar, cinder/slag fill; naph. Odor	X		1.5-2.0				X		X	X			X	X	X											X
TL14-09	Quanta	1	25	3.2	15.0	11.8	cinder/slag intermixed w/in fill, solid coal tar at 9', 12' bgs	X		4.0-6.0						X	X	X		X	X	X		X							X		
	Quanta	1	25	3.2	15.0	11.8	cinder/slag intermixed w/in fill, solid coal tar at 9', 12' bgs	X		10.0-12.0										X	X	X											
TL16-07	Quanta	1	30	0.0	5.0	5.0	cinder/slag intermixed w/in fill	X		0.0-2.0					X	X	X			X	X	X		X		X	X	X	X	X	X		
TL16-09	Quanta	1	25	1.25	3.75	2.5	reddish-purple gravelly silt	X	X	1.0-3.0					X		X			X	X	X				X	X	X	X	X			
TL17-06	Quanta	1	25	0.0	2.0	2.0	gravel, cinders, black and dark brown																										
	Quanta	1	25	2.0	2.5	0.5	dusky red gravelly clay	X	X	3.0-5.0					X	X	X							X								X	
TL17-07	Quanta	1	20	10.0	11.0	1.0	med-coarse sand w/ purplish hue	X	X	10.0-12.0					X	X	X							X								X	
TL17-08	Quanta	1	25	0.0	5.0	5.0	intermixed cinders w/in fill, dusky red fill	X	X	3.0-5.0					X	X	X			X	X	X		X		X	X	X	X	X	X	X	
	Quanta	1	25	0.0	5.0	5.0	intermixed cinders w/in fill, dusky red fill	X		0.0-2.0					X	X	X			X	X	X		X		X	X	X	X	X	X	X	
B-3	Quanta	4		6.0	7.0	1.0	wood and coal tar																										
MW-101	Quanta	4	20	2.0	2.0	trace	black cinders																										
MW-103	Quanta	4	22	3.0	4.0	1.0	cinders, brick, coal tar	X		3.0-4.0					X						X												
MW-105	Quanta	4	20	0.0	12.0	12.0	black cinders	X		5.0-5.0	X				X						X												
MW-106	Quanta	4	24	9.0	18.0	9.0	dark gray silt w/ cinders, slight marsh odor	X		9.0-10.0	X				X						X												
MW-109	Quanta	4	22	0.0	18.0	18.0	fill w/ sand, cobbles, gravel, cinders; brown	X		7.0-7.5		X			X						X												
MW-110	Quanta	4	25	9.0	13.0	4.0	cinders, sand, gravel	X		12.0-13.0	X				X						X												
MW-114B	115 River Road, LLC	1	29	1.0	7.0	6.0	black sandy silt w/ brick, cinder/slag/fill	X		1.5-2.0				X		X	X			X	X	X											
MW-119A	115 River Road, LLC	1	14	4.0	14.0	10.0	gravelly sand w/ crushed brick, cinder/slag	X		14.5-15.0				X		X	X			X	X	X											
MW-119B	115 River Road, LLC	1	16	4.0	16.0	12.0	gravelly sand w/ crushed brick, cinder/slag; various colors	X		9.5-10.0				X		X	X			X	X	X											
SB-01	115 River Road, LLC	1	20	1.0	4.0	3.0	gravelly silty sand w/ wood, cinder/slag; very dark brown	X		1.0-1.5				X		X	X			X	X	X											

Table 4-4  
Cinder/Ash/Coal/Slag and Reddish-Purple Soil Observations and Sampling Summary  
Characterization of Cinder/ Ash and Reddish-Purple Soils  
Quanta Resources Superfund Site, OU1  
Edgewater, New Jersey

Location	Property	Consultant Reference	Total Boring Depth (ft)	Visually Observed Cinder/ Coal/ Ash/ Slag/ Reddish-Purple Interval			Field Log Description	Cinder/ Coal/ Ash/ Slag Sampled	Reddish-Purple Color Present	Sampled Interval (ft bgs)	Soil Sampling Analytical Summary																											
				Interval Top (ft bgs)	Interval Bottom (ft bgs)	Thickness (ft)					PAHs (via 8270)	6020	9014	E160.3	E350.2	SW6010	SW7196	SW7471	SW8081	SW8082	SW8260	SW8270	SW9012	SW9045	SW9060 (TOC)	SPLP, SW6010	SPLP, SW7470	SPLP, SW8082	SPLP, SW8260	SPLP, SW8270	ASTM D1498	ASTM D422	ASTM D4318					
SB-04	115 River Road, LLC	1	30	1.0	3.5	2.5	silty to coarse sand w/ cinder/slag; black	X		1.0-1.5					X																							
	115 River Road, LLC	1	30	1.0	3.5	2.5	silty to coarse sand w/ cinder/slag; black	X		3.0-3.5				X		X	X			X	X	X										X						
MW-101DS	Block 93	1	48	0.3	1.3	1.0	fine sand w/ cinder/slag, black, dry to moist, obvious pet. product odor																															
MW-111A	Block 93	1	30	5.5	6.0	0.5	med-coarse sand w/ crushed brick, cinder/slag/fill																															
MW-111B	Block 93	1	12	5.5	6.0	0.5	black silty sand w/ cobbles, cinder/slag and cloth/cardboard-like material, obvious odor																															
SB-10	Block 93	1	26	0.8	6.0	5.2	sub-angular gravel w/ brick, cinder/slag; black, product stain and odor	X		3.0-4.0				X		X	X	X		X	X	X																
SB-11	Block 93	1	24	0.0	9.5	9.5	sub-angular gravel fill w/ brick, cinder/slag and some fine sand; black, product stain and odor	X		0.0-0.16				X		X	X	X		X	X	X	X															
	Block 93	1	24	0.0	9.5	9.5	sub-angular gravel fill w/ brick, cinder/slag and some fine sand; black, product stain and odor	X		1.5-2.0				X		X	X	X		X	X	X	X															
	Block 93	1	24	0.0	9.5	9.5	sub-angular gravel fill w/ brick, cinder/slag and some fine sand; black, product stain and odor	X		4.5-5.0				X		X	X	X		X	X	X	X															
SB-13	Block 93	1	12	1.0	6.0	5.0	coarse sand w/ cinder/slag/fill; black,layered cardboard-like mat., tar-like product and petro. odor	X		0.0-1.0				X	X	X	X	X		X	X	X	X															
	Block 93	1	12	1.0	6.0	5.0	coarse sand w/ cinder/slag/fill; black, layered cardboard-like mat., tar-like product and petro. odor	X		1.0-2.0				X	X	X	X	X		X	X	X	X															
SB-19	Block 93	1	20	0.0	8.0	8.0	intermixed sandy gravel, crushed brick and black cinder/slag	X		1.0-3.0						X		X			X	X																
	Block 93	1	20	0.0	8.0	8.0	intermixed sandy gravel, crushed brick and black cinder/slag	X		4.0-6.0						X		X			X	X																
SB-20	Block 93	1	30	0.0	6.0	6.0	intermixed black cinder/slag w/in fill (throughout)	X		5.0-7.0						X		X																				
SB-21	Block 93	1	25	0.5	8.0	7.5	intermixed cinder/slag (w/in fill); obvious odor in bottom 3'	X		1.0-3.0						X		X			X	X																
	Block 93	1	25	0.5	8.0	7.5	intermixed cinder/slag (w/in fill); obvious odor in bottom 3'	X		5.0-7.0						X		X			X	X																
SB-22	Block 93	1	25	1.5	18.5	17.0	intermixed black cinder/slag w/in fill, viscous black product, solid tar	X		1.0-3.0						X	X	X													X							
	Block 93	1	25	1.5	18.5	17.0	intermixed black cinder/slag w/in fill, viscous black product, solid tar	X		15.0-17.0						X	X	X												X								
SB-23	Block 93	1	20	0.0	9.0	9.0	intermixed silt and gravel, dk brown cinder/slag w/in fill (throughout)	X		0.0-2.0										X																		
SB-23	Block 93	1	20	0.0	9.0	9.0	intermixed silt and gravel, dk brown cinder/slag w/in fill (throughout)	X		2.0-4.0						X		X		X	X	X																
SB-24	Block 93	1	25	0.5	6.0	5.5	intermixed silt, cinders and crushed gravel	X		0.0-2.0						X	X	X			X	X		X						X								
SB-25	Block 93	1	35	0.0	10.0	10.0	trace black cinders w/in fill	X		0.0-2.0											X	X																
	Block 93	1	35	0.0	10.0	10.0	trace black cinders w/in fill	X		7.0-9.0											X	X																
SB-27	Block 93	1	30	8.25	10.0	1.8	black staining and some cinder/slag w/in fill	X		9.0-10.0																												
TL12-10.75	Block 93	1	30	0.0	16.25	16.25	cinders w/in fill; noticable product odor, black broduct and incandescent sheen	X		0.0-2.0										X																		
TL14-10.75	Block 93	1	25	1.0	20.0	19.0	cinder/slag intermixed w/in fill	X		1.0-3.0					X		X		X	X	X																	
	Block 93	1	25	1.0	20.0	19.0	cinder/slag intermixed w/in fill	X		14.0-16.0					X		X		X	X	X																	
TL12.5-11.75	Block 93	1	25	0.0	10.0	10	cinder/slag intermixed w/in fill																															
TL12.5-12.25	Block 93	1	30	0.7	4.3	3.55	cinder/slag intermixed w/in fill																															
TL12-11.75	Block 93	1	25	0.0	16.25	16.25	intermixed cinders w/in fill																															
TL14-11.25	Block 93	1	30	5.5	6.8	1.3	black, brittle coal tar																															
TL15-10.75	Block 93	1	50	4.25	7.5	3.3	crushed cinder/slag w/in fill; sheen and product odor																															
TL17-05	Former Celotex	1	30	3.5	5.0	1.5	some crushed cinder/slag w/in fill																															
TL18.5-01.5	Former Celotex	1	25	17.5	20.0	2.5	traces dark gray fibrous wood																															
TL19-0.5	Former Celotex	1	30	27.5	27.5	0.0	trace wood w/in fractured rock; obvious odor	X		28.0-29.5										X	X	X																
SS-18B	Former Celotex	2	22.5	13.0	14.0	1.0	little slag w/in fill	X		14.5-15.0	X																											
SS-19.5B	Former Celotex	2	18	11.0	11.0	trace	3-4" grey ash																															
SS-20C	Former Celotex	2	16	14.0	14.5	0.5	black sandy silt w/ wood																															
SS-22B	Former Celotex	2	20	13.5	14.8	1.3	purple lenses, trace wood	X	X	14.0-14.5	X																											
SS-23A	Former Celotex	2	21.5	12.0	17.0	5.0	black slag w/in sandy fill; throughout interval	X		10.0-14.0	X																											
SB-V12	Former Celotex	3	17	4.0	7.0	3.0	purple-red silt	X	X	6.0-6.5		X	X					X	X	X	X	X																

Cinder/Ash/Coal/Slag and Reddish-Purple Soil Observations and Sampling Summary  
 Characterization of Cinder/ Ash and Reddish-Purple Soils  
*Quanta Resources Superfund Site, OU1*  
*Edgewater, New Jersey*

Page 3 of 4  
**306217**



Table 4-4  
Cinder/Ash/Coal/Slag and Reddish-Purple Soil Observations and Sampling Summary  
Characterization of Cinder/ Ash and Reddish-Purple Soils  
Quanta Resources Superfund Site, OU1  
Edgewater, New Jersey

Location	Property	Consultant Reference	Total Boring Depth (ft)	Visually Observed Cinder/ Coal/ Ash/ Slag/ Reddish-Purple Interval			Field Log Description	Cinder/ Coal/ Ash/ Slag Sampled	Reddish-Purple Color Present	Sampled Interval (ft bgs)	Soil Sampling Analytical Summary																						
				Interval Top (ft bgs)	Interval Bottom (ft bgs)	Thickness (ft)					PAHs (via 8270)	6020	9014	E160.3	E350.2	SW6010	SW7196	SW7471	SW8081	SW8082	SW8260	SW8270	SW9012	SW9045	SW9060 (TOC)	SPLP, SW6010	SPLP, SW7470	SPLP, SW8082	SPLP, SW8260	SPLP, SW8270	ASTM D1498	ASTM D422	ASTM D4318
SB-36	Quanta	1	10	5.9	6.7	0.8	black fine sand, little coal, gravel, coarse sand, brick and cinder/slag	X		5.9-6.7						X		X							X								
SB-36	Quanta	1	10	1.2	5.2	4.0	dusky red/ very dusky red fine to coarse sand and gravel	X	X	1.2-2.2															X	X	X						
	Quanta	1	10	1.2	5.2	4.0	dusky red/ very dusky red fine to coarse sand and gravel	X	X	3.2-5.2						X		X							X								
SB-37	Quanta	1	11	3.9	5.0	1.1	very dusky red medium sand, little cinder/slag	X	X	3.9-5.0						X		X							X								
SB-38	Quanta	1	10	1.7	7.3	5.6	very dark brown grading to reddish brown fine sand, little coarse sand and gravel	X	X	1.7-3.4						X		X							X	X	X						
	Quanta	1	10	1.7	7.3	5.6	dark red coarse sand and gravel, trace silt, coal tar	X	X	3.4-7.3						X		X							X								

Summary of Cinder/ Coal/ Ash/ Slag and Reddish-Purple Soil Visual Observations and Samples

Property	# of Locations where Cinder/ Coal/ Ash/ Slag or Reddish-Purple Soils Observed	# of Locations where Reddish-Purple Soil Observed	# of Samples Collected	# of Samples of Reddish-Purple Soil Intervals
115 River Road, LLC	5	0	6	0
Block 93	25	0	26	0
Former Celotex	25	10	9	4
Former Lever Bros.	32	0	19	0
Quanta	31	7	31	9
Total:	118	17	91	13

Notes:  
UNK - Unknown  
NA - Not Available  
N/A - Not Applicable  
Consultant Reference:  
1. CH2M HILL  
2. Environ  
3. Environmental Waste Management Associates  
4. GeoSyntec  
5. GZA  
6. Langan Engineering  
7. TRC Raviv Associates, Inc.

**TABLE 4-5**

Soil Screening Criteria

Quanta Resources Superfund Site, OU1

Edgewater, New Jersey

Parameter	NJ Residential Direct Contact Soil Cleanup Criteria (mg/kg)	NJ Non-Residential Direct Contact Soil Cleanup Criteria (mg/kg)	NJ Impact to Groundwater Soil Cleanup Criteria (mg/kg)	EPA Region 9 Residential Soil PRG (mg/kg)	EPA Region 9 Industrial Soil PRG (mg/kg)
[1,1-Biphenyl]-4,4-Diamine, 3,3-Dimethyl-	NA	NA	NA	NA	NA
1,1,1,2-Tetrachloroethane	170	310	1	3.2E+00	7.3E+00
1,1,1-Trichloroethane	210	1000	50	1.2E+03	1.2E+03
1,1,2,2-Tetrachloroethane	34	70	1	4.1E-01	9.30E-01
1,1,2-Trichloroethane	22	420	1	7.3E-01	1.6E+00
1,1,2-Trichlorotrifluoroethane	NA	NA	NA	NA	NA
1,1'-Biphenyl	NA	NA	NA	3.0E+03	2.3E+04
1,1-Dichloroethane	570	1000	10	5.1E+02	1.7E+03
1,1-Dichloroethene	8	150	10	1.2E+02	4.1E+02
1,1-Dichloropropene	NA	NA	NA	NA	NA
1,2,3-Trichlorobenzene	NA	NA	NA	NA	NA
1,2,3-Trichloropropane	NA	NA	NA	3.4E-02	7.6E-02
1,2,4,5-Tetrachlorobenzene	NA	NA	NA	1.8E+01	1.8E+02
1,2,4-Trichlorobenzene	68	1200	100	6.2E+01	2.2E+02
1,2,4-Trimethylbenzene	NA	NA	NA	5.2E+01	1.7E+02
1,2-Dibromo-3-Chloropropane	NA	NA	NA	4.6E-01	2.0E+00
1,2-Dibromoethane	NA	NA	NA	3.2E-02	7.3E-02
1,2-Dichlorobenzene	5100	10000	50	6.0E+02	6.0E+02
1,2-Dichloroethane	6	24	1	2.8E-01	6.0E-01
1,2-Dichloropropane	10	43	NA	3.4E-01	7.4E-01
1,2-Diphenylhydrazine/Azobenzene	NA	NA	NA	6.1E-01	2.2E+00
1,3,5-Trimethylbenzene	NA	NA	NA	1.8E+03	1.8E+04
1,3-Dichlorobenzene	5100	10000	100	5.3E+02	6.0E+02
1,3-Dichloropropane	NA	NA	NA	1.0E+02	3.6E+02
1,3-Dichloropropene	4	5	1	7.8E-01	1.8E+00
1,4-Dichlorobenzene	NA	NA	NA	3.4E+00	7.9E+00
2,2-Dichloropropane	NA	NA	NA	NA	NA
2,2'-Oxybis(1-Chloropropane)	NA	NA	NA	NA	NA
2,3-Dihydro-1,1,4-1h-Indene	NA	NA	NA	NA	NA
2,4,5-Trichlorophenol	5600	10000	50	6.1E+03	6.2E+04

**TABLE 4-5**

Soil Screening Criteria

*Quanta Resources Superfund Site, OU1**Edgewater, New Jersey*

<b>Parameter</b>	<b>NJ Residential Direct Contact Soil Cleanup Criteria (mg/kg)</b>	<b>NJ Non-Residential Direct Contact Soil Cleanup Criteria (mg/kg)</b>	<b>NJ Impact to Groundwater Soil Cleanup Criteria (mg/kg)</b>	<b>EPA Region 9 Residential Soil PRG (mg/kg)</b>	<b>EPA Region 9 Industrial Soil PRG (mg/kg)</b>
2,4,6-Trichlorophenol	62	270	10	6.1E+00	6.2E+01
2,4-Dichlorophenol	170	3100	10	1.8E+02	1.8E+03
2,4-Dimethylphenol	1100	10000	10	1.2E+03	1.2E+04
2,4-Dinitrophenol	110	2100	10	1.2E+02	1.2E+03
2,4-Dinitrotoluene	1	4	10	1.2E+02	1.2E+03
2,6-Dinitrotoluene	1	4	10	6.1E+01	6.2E+02
2-Butanone	1000	1000	50	2.2E+04	1.1E+05
2-Chloroethyl Vinyl Ether	NA	NA	NA	NA	NA
2-Chloronaphthalene	NA	NA	NA	4.9E+03	2.3E+04
2-Chlorophenol	280	5200	10	6.3E+01	2.4E+02
2-Chlorotoluene	NA	NA	NA	NA	NA
2-Hexanone	NA	NA	NA	NA	NA
2-Methylnaphthalene	NA	NA	NA	NA	NA
2-Methylphenol	2800	10000	NA	3.1E+03	3.1E+04
2-Nitroaniline	NA	NA	NA	1.8E+02	1.8E+03
2-Nitrophenol	NA	NA	NA	NA	NA
3&4-Methylphenol	2800	10000	NA	3.1E+02	3.1E+03
3,3'-Dichlorobenzidine	2	6	100	1.1E+00	3.8E+00
3-Methylphenol	2800	10000	NA	3.1E+03	3.1E+04
3-Nitroaniline	NA	NA	NA	1.8E+01	8.2E+01
4,4'-DDD	3	12	50	2.4E+00	1.0E+01
4,4'-DDE	2	9	50	1.7E+00	7.0E+00
4,4'-DDT	2	9	500	1.7E+00	7.0E+00
4,6-Dinitro-2-Methylphenol	NA	NA	NA	NA	NA
4-Bromophenyl Phenyl Ether	NA	NA	NA	NA	NA
4-Carene	NA	NA	NA	NA	NA
4-Chloro-3-Methylphenol	10000	10000	100	NA	NA
4-Chloroaniline	230	4200	NA	2.4E+02	2.5E+03
4-Chlorophenyl Phenyl Ether	NA	NA	NA	NA	NA
4-Chlorotoluene	NA	NA	NA	NA	NA
4-Methyl-2-Pentanone	1000	1000	50	NA	NA
4-Methylphenol	2800	10000	NA	3.1E+02	3.1E+03
4-Nitroaniline	NA	NA	NA	2.3E+01	8.2E+01
4-Nitrophenol	NA	NA	NA	NA	NA

**TABLE 4-5**

Soil Screening Criteria

Quanta Resources Superfund Site, OU1

Edgewater, New Jersey

Parameter	NJ Residential Direct Contact Soil Cleanup Criteria (mg/kg)	NJ Non-Residential Direct Contact Soil Cleanup Criteria (mg/kg)	NJ Impact to Groundwater Soil Cleanup Criteria (mg/kg)	EPA Region 9 Residential Soil PRG (mg/kg)	EPA Region 9 Industrial Soil PRG (mg/kg)
Acenaphthene	3400	10000	100	3.7E+03	2.9E+04
Acenaphthylene	NA	NA	NA	NA	NA
Acetone	1000	1000	100	1.4E+04	5.4E+04
Acetophenone	NA	NA	NA	NA	NA
Acrolein	NA	NA	NA	1.0E-01	3.4E-01
Acrylonitrile	1	5	1	2.1E-01	4.9E-01
Aldrin	0.04	0.17	50	2.9E-02	1.0E-01
Alpha-BHC	NA	NA	NA	9.0E-02	3.6E-01
Alpha-Chlordane	NA	NA	NA	NA	NA
Aluminum	NA	NA	NA	7.6E+04	1.0E+05
Ammonia	NA	NA	NA	NA	NA
Aniline	NA	NA	NA	8.5E+01	3.0E+02
Anthracene	10000	10000	100	2.2E+04	1.0E+05
Antimony	14	340	NA	3.1E+01	4.1E+02
Aroclor-1016	0.49	2	50	3.9E+00	2.1E+01
Aroclor-1221	0.49	2	50	3.9E+00	2.1E+01
Aroclor-1232	0.49	2	50	3.9E+00	2.1E+01
Aroclor-1242	0.49	2	50	2.2E-01	7.4E-01
Aroclor-1248	0.49	2	50	2.2E-01	7.4E-01
Aroclor-1254	0.49	2	50	2.2E-01	7.4E-01
Aroclor-1260	0.49	2	50	2.2E-01	7.4E-01
Aroclor-1262	0.49	2	50	2.2E-01	7.4E-01
Aroclor-1268	0.49	2	50	2.2E-01	7.4E-01
Arsenic	20	20	NA	3.9E-01	1.6E+00
Atrazine	NA	NA	NA	2.2E+00	7.8E+00
Barium	700	47000	NA	5.4E+03	6.7E+04
Benzaldehyde	NA	NA	NA	6.1E+03	6.2E+04
Benzene	3	13	1	6.4E-01	1.4E+00
Benzidine	NA	NA	NA	2.1E-03	7.5E-03
Benzo(a)anthracene	0.9	4	500	6.2E-01	2.1E+00
Benzo(a)pyrene	0.66	0.66	100	6.0E-02	2.1E-01
Benzo(b)fluoranthene	0.9	4	50	6.2E-01	2.1E+00
Benzo(g,h,i)perylene	NA	NA	NA	NA	NA
Benzo(k)fluoranthene	0.9	4	500	6.2E+00	2.1E+01

**TABLE 4-5**

Soil Screening Criteria

Quanta Resources Superfund Site, OU1

Edgewater, New Jersey

Parameter	NJ Residential Direct Contact Soil Cleanup Criteria (mg/kg)	NJ Non-Residential Direct Contact Soil Cleanup Criteria (mg/kg)	NJ Impact to Groundwater Soil Cleanup Criteria (mg/kg)	EPA Region 9 Residential Soil PRG (mg/kg)	EPA Region 9 Industrial Soil PRG (mg/kg)
Benzofuran	NA	NA	NA	NA	NA
Benzoic Acid	NA	NA	NA	1.0E+05	1.0E+05
Benzyl Alcohol	10000	10000	50	1.8E+04	1.0E+05
Beryllium	2	2	NA	1.5E+02	1.9E+03
Beta-BHC	NA	NA	NA	3.2E-01	1.3E+00
Beta-Chlordane	NA	NA	NA	NA	NA
Bis(2-Chloroethoxy)methane	NA	NA	NA	NA	NA
Bis(2-Chloroethyl)ether	0.66	3	10	NA	NA
Bis(2-Chloroisopropyl)ether	2300	10000	10	NA	NA
Bis(2-Ethylhexyl)phthalate	49	210	100	3.5E+01	1.2E+02
Bromobenzene	NA	NA	NA	2.8E+01	9.2E+01
Bromochloromethane	NA	NA	NA	NA	NA
Bromodichloromethane	11	46	1	8.2E-01	1.8E+00
Bromoform	86	370	1	6.2E+01	2.2E+02
Bromomethane	79	1000	1	3.9E+00	1.3E+01
Butylbenzene	NA	NA	NA	NA	NA
Butylbenzyl Phthalate	1100	10000	100	1.2E+04	1.0E+05
Cadmium	39	100	NA	3.7E+01	4.5E+02
Calcium	NA	NA	NA	NA	NA
Caprolactam	NA	NA	NA	3.1E+04	1.0E+05
Carbazole	NA	NA	NA	2.4E+01	8.6E+01
Carbon Disulfide	NA	NA	NA	3.6E+02	7.2E+02
Carbon Tetrachloride	2	4	1	2.5E-01	5.5E-01
Chlordane	NA	NA	NA	1.6E+00	6.5E+00
Chlorobenzene	37	680	1	1.5E+02	5.3E+02
Chlorodibromomethane	110	1000	1	NA	NA
Chloroethane	NA	NA	NA	3.0E+00	6.5E+00
Chloroform	19	28	1	2.2E-01	4.7E-01
Chloromethane	520	1000	10	4.7E+01	1.6E+02
Chromium	NA	NA	NA	2.1E+02	4.5E+02
Chromium III	120000	NA	NA	1.0E+05	1.0E+05
Chromium VI	240	20	NA	3.0E+01	6.4E+01
Chrysene	9	40	500	6.2E+01	2.1E+02
Cis-1,2-Dichloroethene	79	1000	1	4.3E+01	1.5E+02

**TABLE 4-5**

Soil Screening Criteria

*Quanta Resources Superfund Site, OU1**Edgewater, New Jersey*

<b>Parameter</b>	<b>NJ Residential Direct Contact Soil Cleanup Criteria (mg/kg)</b>	<b>NJ Non-Residential Direct Contact Soil Cleanup Criteria (mg/kg)</b>	<b>NJ Impact to Groundwater Soil Cleanup Criteria (mg/kg)</b>	<b>EPA Region 9 Residential Soil PRG (mg/kg)</b>	<b>EPA Region 9 Industrial Soil PRG (mg/kg)</b>
Cis-1,3-Dichloropropene	NA	NA	NA	1.0E+02	3.6E+02
Cobalt	NA	NA	NA	9.0E+02	1.9E+03
Copper	600	600	NA	3.1E+03	4.1E+04
Cyanide	1100	21000	NA	1.2E+03	1.2E+04
Cyclohexane	NA	NA	NA	1.4E+02	1.4E+02
Cyclopentane	NA	NA	NA	NA	NA
Delta-BHC	NA	NA	NA	NA	NA
Dibenzo(a,h)anthracene	0.66	0.66	100	6.2E-02	2.1E-01
Dibenzofuran	NA	NA	NA	1.5E+02	1.6E+03
Dibromomethane	NA	NA	NA	NA	NA
Dichlorodifluoromethane	NA	NA	NA	9.4E+01	3.1E+02
Dieldrin	0.042	0.18	50	3.0E-02	1.1E-01
Diethyl Phthalate	10000	10000	50	4.9E+04	1.0E+05
Dimethyl Phthalate	10000	10000	50	1.0E+05	1.0E+05
Di-n-butyl Phthalate	5700	10000	100	NA	NA
Di-n-octyl Phthalate	1100	10000	100	2.4E+03	2.5E+04
Endosulfan I	340	6200	50	3.7E+02	2.7E+03
Endosulfan II	340	6200	50	3.7E+02	2.7E+03
Endosulfan Sulfate	NA	NA	NA	NA	NA
Endrin	17	310	50	1.8E+01	1.8E+02
Endrin Aldehyde	NA	NA	NA	NA	NA
Endrin Ketone	NA	NA	NA	NA	NA
Ethylbenzene	1000	1000	100	4.0E+02	4.0E+02
Ethylmethylbenzene	NA	NA	NA	NA	NA
Ethylmethylbenzene	NA	NA	NA	NA	NA
Fluoranthene	2300	10000	100	2.3E+03	2.2E+04
Fluorene	2300	10000	100	2.7E+03	2.6E+04
Gamma-BHC (Lindane)	0.52	2.2	50	4.4E-01	1.7E+00
Gamma-Chlordane	NA	NA	NA	NA	NA
Heptachlor	0.15	0.65	50	1.1E-01	3.8E-01
Heptachlor Epoxide	NA	NA	NA	5.3E-02	1.9E-01
Hexachlorobenzene	0.66	2	100	3.0E-01	1.1E+00
Hexachlorobutadiene	1	21	100	6.2E+00	2.2E+01
Hexachlorocyclopentadiene	400	7300	100	3.7E+02	3.7E+03

**TABLE 4-5**

Soil Screening Criteria

Quanta Resources Superfund Site, OU1

Edgewater, New Jersey

Parameter	NJ Residential Direct Contact Soil Cleanup Criteria (mg/kg)	NJ Non-Residential Direct Contact Soil Cleanup Criteria (mg/kg)	NJ Impact to Groundwater Soil Cleanup Criteria (mg/kg)	EPA Region 9 Residential Soil PRG (mg/kg)	EPA Region 9 Industrial Soil PRG (mg/kg)
Hexachloroethane	6	100	100	3.5E+01	1.2E+02
Indeno(1,2,3-cd)pyrene	0.9	4	500	6.2E-01	2.1E+00
Iron	NA	NA	NA	2.3E+04	1.0E+05
Isophorone	1100	10000	50	5.1E+02	5.1E+02
Isopropylbenzene	NA	NA	NA	5.7E+02	2.0E+03
Lead	400	600	NA	4.0E+02	8.0E+02
Magnesium	NA	NA	NA	NA	NA
Manganese	NA	NA	NA	1.8E+03	1.9E+04
Mercury	14	270	NA	2.3E+01	3.1E+02
Methoxychlor	280	5200	50	3.1E+02	3.1E+03
Methyl Acetate	NA	NA	NA	2.2E+04	9.2E+04
Methyl Tert-butyl Ether (MTBE)	NA	NA	NA	3.2E+01	7.0E+01
Methylcyclohexane	NA	NA	NA	2.6E+03	8.7E+03
Methylene chloride	49	210	1	9.1E+00	2.1E+01
Methylpropylbenzene	NA	NA	NA	NA	NA
m-Xylene	NA	NA	NA	NA	NA
Naphthalene	230	4200	100	5.6E+01	1.9E+02
Nickel	250	2400	NA	1.6E+03	2.0E+04
Nitrobenzene	28	520	10	2.0E+01	1.0E+02
n-Nitrosodimethylamine	140	600	100	9.5E-03	3.4E-02
n-Nitroso-di-n-propylamine	0.66	0.66	10	6.9E-02	2.5E-01
n-Nitrosodiphenylamine	140	600	100	9.9E+01	3.5E+02
n-Propylbenzene	NA	NA	NA	2.4E+02	2.4E+02
o-Xylene	NA	NA	NA	NA	NA
Pentachlorophenol	6	24	100	3.0E+00	9.0E+00
Phenanthrene	NA	NA	NA	NA	NA
Phenol	10000	10000	50	1.8E+04	1.0E+05
Phenols (Total)	NA	NA	NA	NA	NA
p-Isopropyltoluene	NA	NA	NA	NA	NA
Potassium	NA	NA	NA	NA	NA
Pyrene	1700	10000	100	2.3E+03	2.9E+04
sec-Butylbenzene	NA	NA	NA	2.2E+02	2.2E+02
Selenium	63	3100	NA	3.9E+02	5.1E+03
Silver	110	4100	NA	3.9E+02	5.1E+03
Sodium	NA	NA	NA	NA	NA

**TABLE 4-5**

Soil Screening Criteria

*Quanta Resources Superfund Site, OU1**Edgewater, New Jersey*

<b>Parameter</b>	<b>NJ Residential Direct Contact Soil Cleanup Criteria (mg/kg)</b>	<b>NJ Non-Residential Direct Contact Soil Cleanup Criteria (mg/kg)</b>	<b>NJ Impact to Groundwater Soil Cleanup Criteria (mg/kg)</b>	<b>EPA Region 9 Residential Soil PRG (mg/kg)</b>	<b>EPA Region 9 Industrial Soil PRG (mg/kg)</b>
Styrene	23	97	100	1.7E+03	1.7E+03



**TABLE 4-5**

Soil Screening Criteria

*Quanta Resources Superfund Site, OU1**Edgewater, New Jersey*

<b>Parameter</b>	<b>NJ Residential Direct Contact Soil Cleanup Criteria (mg/kg)</b>	<b>NJ Non-Residential Direct Contact Soil Cleanup Criteria (mg/kg)</b>	<b>NJ Impact to Groundwater Soil Cleanup Criteria (mg/kg)</b>	<b>EPA Region 9 Residential Soil PRG (mg/kg)</b>	<b>EPA Region 9 Industrial Soil PRG (mg/kg)</b>
Tert-butyl Alcohol	NA	NA	NA	NA	NA
Tert-butylbenzene	NA	NA	NA	3.9E+02	3.9E+02
Tetrachloroethene	4	6	1	4.8E-01	1.3E+00
Tetramethylbenzene	NA	NA	NA	NA	NA
Thallium	2	2	NA	5.2E+00	6.7E+01
Toluene	1000	1000	500	5.2E+02	5.2E+02
Total Petroleum Hydrocarbons (TPH)	NA	NA	NA	NA	NA
Toxaphene	0.10	0.2	50	4.4E-01	1.6E+00
Trans-1,2-Dichloroethene	1000	1000	50	6.9E+01	2.3E+02
Trans-1,3-Dichloropropene	NA	NA	NA	NA	NA
Trichloroethene	23	54	1	5.20E-02	1.10E-01
Trichlorofluoromethane	NA	NA	NA	3.9E+02	2.0E+03
Trimethylbenzene	NA	NA	NA	NA	NA
Vanadium	370	7100	NA	7.8E+01	1.0E+03
Vinyl chloride	2	7	10	7.9E-02	7.5E-01
Xylenes, m & p	NA	NA	NA	NA	NA
Xylenes, o & p	NA	NA	NA	NA	NA
Xylenes, Total	410	1000	67	2.7E+02	4.2E+02
Zinc	1500	1500	NA	2.4E+04	1.0E+05

**Notes:**

mg/kg - milligrams per kilogram

NA - No Applicable Standard

PRG - Preliminary Remediation Goal

**Sources:**New Jersey Soil Cleanup Criteria: <http://www.state.nj.us/dep/srp/regs/scc>, accessed March 13, 2007.USEPA Region 9 PRG Table: <http://www.epa.gov/region09/waste/sfund/prg/files/04prgtable.pdf>, accessed March 13, 2007.

Table 4-6

Constituents of Interest in Soil  
 Quanta Resources Superfund Site, OU1  
 Edgewater, New Jersey

Parameter	Lowest Screening Criterion (mg/kg)		Total Number of Samples	Number of Samples in which Parameter was Detected	Number of Samples Exceeding Lowest Screening Criterion	Exceedance Rate	Maximum Concentration Detected in Unsaturated Soil 0-4 ft bgs (mg/kg)	Maximum Concentration Detected in Saturated Soil >4 ft bgs (mg/kg)
<b>Inorganics</b>								
Antimony	NJ RDCSCC	14	375	194	29	7.7%	205	135
Arsenic	Region 9 Res. PRG	0.39	665	636	632	95.0%	35100	5700
Barium	NJ RDCSCC	700	202	200	1	0.5%	N/A	721
Beryllium	NJ RDCSCC & NJ NRDCSCC	2	352	282	6	1.7%	4.5	565
Chromium	Region 9 Res. PRG	210	477	450	2	0.4%	N/A	676
Copper	NJ RDCSCC & NJ NRDCSCC	600	355	354	16	4.5%	9690	4540
Iron	Region 9 Res. PRG	24000	214	214	67	31.3%	257000	274000
Lead	NJ RDCSCC & Region 9 Res. PRG	400	573	571	108	18.8%	38800	12000
Mercury	NJ RDCSCC	14	403	388	14	3.5%	69.2	316
Nickel	NJ RDCSCC	250	371	352	4	1.1%	1900	661
Selenium	NJ RDCSCC	63	367	209	4	1.1%	302	168
Thallium	NJ RDCSCC & NJ NRDCSCC	2	358	227	43	12.0%	36.2	84.2
Vanadium	Region 9 Res. PRG	78	205	203	6	2.9%	106	155
Zinc	NJ RDCSCC & NJ NRDCSCC	1500	346	340	7	2.0%	3820	5410
<b>VOCs</b>								
Benzene	Region 9 Res. PRG	0.64	467	190	97	20.8%	35.4	327
Ethylbenzene	NJ IGWSCC	100	418	180	9	2.2%	N/A	290
Methylene chloride	NJ IGWSCC	1	456	26	2	0.4%	N/A	3.7
Styrene	NJ RDCSCC	23	391	17	2	0.5%	N/A	57.0
Tetrachloroethene	Region 9 Res. PRG	0.48	452	16	7	1.5%	0.72	3.2
Trichloroethene	Region 9 Res. PRG	0.05	463	12	9	1.9%	0.54	0.18
Vinyl chloride	Region 9 Res. PRG	0.07	452	1	1	0.2%	0.096	N/A
Xylenes, total	NJ IGWSCC	67	402	195	30	7.5%	270	891
<b>PAHs</b>								
Acenaphthene	NJ IGWSCC	100	793	597	76	9.6%	1900	3480
Anthracene	NJ IGWSCC	100	842	704	82	9.7%	1510	2660
Benzo(a)anthracene	Region 9 Res. PRG	0.62	864	769	538	62.3%	3700	2100
Benzo(a)pyrene	Region 9 Res. PRG	0.06	867	763	652	75.2%	3500	2200
Benzo(b)fluoranthene	Region 9 Res. PRG	0.62	861	757	537	62.4%	4100	2790
Benzo(k)fluoranthene	NJ RDCSCC	0.9	865	736	451	52.1%	2000	1400
Chrysene	NJ RDCSCC	9	872	775	221	25.3%	4200	2300
Dibenzo(a,h)anthracene	Region 9 Res. PRG	0.06	780	528	467	59.9%	510	390
Fluoranthene	NJ IGWSCC	100	862	788	132	15.3%	10000	6100
Fluorene	NJ IGWSCC	100	797	595	75	9.4%	1400	4160
Indeno(1,2,3-cd)pyrene	Region 9 Res. PRG	0.62	847	695	449	53.0%	1700	1300
Naphthalene	Region 9 Res. PRG	56	780	544	111	14.2%	10000	26000
Pyrene	NJ IGWSCC	100	862	789	126	14.6%	8700	5400
<b>Non-PAH SVOCs</b>								
2,4-Dimethylphenol	NJ IGWSCC	10	365	43	13	3.6%	340	280
2,4-Dinitrotoluene	NJ RDCSCC	1	542	9	6	1.1%	17	29
2,6-Dinitrotoluene	NJ RDCSCC	1	524	1	1	0.2%	N/A	6.94
4-Methylphenol	Region 9 Res. PRG	310	251	31	1	0.4%	630	N/A
4-Nitroaniline	Region 9 Res. PRG	23	489	5	3	0.6%	49	58
Bis(2-ethylhexyl)phthalate	Region 9 Res. PRG	35	567	219	1	0.2%	167	N/A
Carbazole	Region 9 Res. PRG	24	522	362	72	13.8%	1200	630
Dibenzofuran	Region 9 Res. PRG	150	508	332	36	7.1%	1300	2800
Hexachlorobutadiene	NJRDCSCC	1	528	5	1	0.2%	1.42	N/A
Phenol	NJ IGWSCC	50	365	38	6	1.6%	460	140

**Table 4-6**

Constituents of Interest in Soil  
*Quanta Resources Superfund Site, OU1*  
*Edgewater, New Jersey*

			Total Number of Samples	Number of Samples in which Parameter was Detected	Number of Samples Exceeding Lowest Screening Criterion	Exceedance Rate	Maximum Concentration Detected in Unsaturated Soil 0-4 ft bgs (mg/kg)	Maximum Concentration Detected in Saturated Soil >4 ft bgs (mg/kg)
Parameter	Lowest Screening Criterion (mg/kg)							
Pesticides and PCBs								
Aroclor-1242	Region 9 Res. PRG	0.22	344	14	12	3.5%	3.2	0.643
Aroclor-1248	Region 9 Res. PRG	0.22	344	4	2	0.6%	0.77	N/A
Aroclor-1254	Region 9 Res. PRG	0.22	344	48	18	5.2%	0.38	1.54
Aroclor-1260	Region 9 Res. PRG	0.22	344	74	22	6.4%	1.2	0.269
Heptachlor	Region 9 Res. PRG	0.11	177	5	1	0.6%	0.35	N/A

Notes:

All concentrations are presented in milligrams per kilogram (mg/kg).

Only constituents exceeding the lowest of the screening criteria are included in this table.

N/A = No constituents in this zone exceeded the applicable screening criterion.

IGWSCC = New Jersey Impact to Groundwater Soil Cleanup Criteria, <http://www.state.nj.us/dep/srp/regs/scc>, accessed March 13, 2007.

NJ RDCSCC = New Jersey Residential Soil Cleanup Criteria, <http://www.state.nj.us/dep/srp/regs/scc>, accessed March 13, 2007.

NJ NRDCSCC = New Jersey Non-Residential Soil Cleanup Criteria, <http://www.state.nj.us/dep/srp/regs/scc>, accessed March 13, 2007.

Region 9 Residential PRG = USEPA Region 9 Preliminary Remediation Goal Table: <http://www.epa.gov/region09/waste/sfund/prg/files/04prgtable.pdf>, accessed March 13, 2007.

TABLE 4-7

Groundwater Screening Criteria  
 Quanta Resources Superfund Site, OU1  
 Edgewater, New Jersey

Parameter	New Jersey Class IIA Groundwater Quality Criterion* (ug/L)	New Jersey Interim Generic Groundwater Quality Criteria (ug/L)	EPA Region 9 Tap Water Preliminary Remediation Goal (ug/L)
1,1,1-Trichloroethane	30	NA	3.2E+03
1,1,2,2-Tetrachloroethane	1	NA	5.5E-02
1,1,2-Trichloroethane	3	NA	2.0E-01
1,1,2-Trichlorotrifluoroethane	NA	100	NA
1,1'-Biphenyl	400	NA	3.0E+02
1,1-Dichloroethane	50	NA	8.1E+02
1,1-Dichloroethene	1	NA	3.4E+02
1,2,4-Trichlorobenzene	9	NA	7.2E+00
1,2-Dibromo-3-Chloropropane	0.02	NA	4.8E-02
1,2-Dibromoethane	0.03	NA	5.6E-03
1,2-Dichlorobenzene	600	NA	3.7E+02
1,2-Dichloroethane	2	NA	1.2E-01
1,2-Dichloropropane	1	NA	1.6E-01
1,3-Dichlorobenzene	600	NA	1.8E+02
1,4-Dichlorobenzene	75	NA	5.0E-01
2,2'-Oxybis(1-Chloropropane)	NA	NA	NA
2,4,5-Trichlorophenol	700	NA	3.6E+03
2,4,6-Trichlorophenol	20	NA	3.6E+00
2,4-Dichlorophenol	20	NA	1.1E+02
2,4-Dimethylphenol	100	NA	7.3E+02
2,4-Dinitrophenol	40	NA	7.3E+01
2,4-Dinitrotoluene	10	NA	7.3E+01
2,6-Dinitrotoluene	10	NA	3.6E+01
2-Butanone	300	NA	7.0E+03
2-Chloronaphthalene	600	NA	4.9E+02
2-Chlorophenol	40	NA	3.0E+01
2-Hexanone	NA	100	NA
2-Methylnaphthalene	NA	100	NA
2-Methylphenol	NA	100	1.8E+03
2-Nitroaniline	NA	100	1.1E+02
2-Nitrophenol	NA	100	NA
3&4-Methylphenol	NA	100	NA
3,3'-Dichlorobenzidine	30	NA	1.5E-01
3-Nitroaniline	NA	5	3.2E+00
4,4'-DDD	0.1	NA	2.8E-01
4,4'-DDE	0.1	NA	2.0E-01
4,4'-DDT	0.1	NA	2.0E-01
4,6-Dinitro-2-Methylphenol	NA	100	NA
4-Bromophenyl Phenyl Ether	NA	100	NA
4-Chloro-3-Methylphenol	NA	100	NA
4-Chloroaniline	30	NA	1.5E+02
4-Chlorophenyl Phenyl Ether	NA	100	NA
4-Methyl-2-Pentanone	NA	100	NA
4-Methylphenol	NA	100	1.8E+02
4-Nitroaniline	NA	100	3.2E+00
4-Nitrophenol	NA	100	NA
Acenaphthene	400	NA	3.7E+02
Acenaphthylene	NA	100	NA
Acetone	6000	NA	5.5E+03
Acetophenone	700	NA	NA
Aldrin	0.04	NA	4.0E-03
Alpha-BHC	0.02	NA	1.1E-02
Alpha-Chlordane	NA	100	NA
Ammonia	3000	NA	NA
Anthracene	2000	NA	1.8E+03
Aroclor-1016	0.5	NA	9.6E-01
Aroclor-1221	0.5	NA	NA

TABLE 4-7

Groundwater Screening Criteria  
 Quanta Resources Superfund Site, OU1  
 Edgewater, New Jersey

Parameter	New Jersey Class IIA Groundwater Quality Criterion* (ug/L)	New Jersey Interim Generic Groundwater Quality Criteria (ug/L)	EPA Region 9 Tap Water Preliminary Remediation Goal (ug/L)
Aroclor-1232	0.5	NA	NA
Aroclor-1242	0.5	NA	9.6E-01
Aroclor-1248	0.5	NA	NA
Aroclor-1254	0.5	NA	3.4E-02
Aroclor-1260	0.5	NA	3.4E-02
Arsenic	3	NA	4.5E-02
Arsenic (III)	3	NA	4.5E-02
Arsenic (V)	3	NA	4.5E-02
Atrazine	3	NA	3.0E-01
Benzaldehyde	NA	100	3.6E+03
Benzene	1	NA	3.5E-01
Benzo(a)anthracene	0.1	NA	9.2E-02
Benzo(a)pyrene	0.1	NA	9.2E-03
Benzo(b)fluoranthene	0.2	NA	9.2E-02
Benzo(g,h,i)perylene	NA	100	NA
Benzo(k)fluoranthene	0.5	NA	9.2E-01
Beta-BHC	0.04	NA	3.7E-02
Beta-Chlordane	NA	100	NA
Bis(2-Chloroethoxy)methane	NA	100	NA
Bis(2-Chloroethyl)ether	7	NA	1.0E-02
Bis(2-Chloroisopropyl)ether	300	NA	2.7E-01
Bis(2-Ethylhexyl)phthalate	3	NA	4.8E+00
Bromodichloromethane	1	NA	1.8E-01
Bromoform	4	NA	8.5E+00
Bromomethane	NA	100	8.7E+00
Butylbenzyl Phthalate	100	NA	7.3E+03
Cacodylic Acid	NA	100	NA
Caprolactam	NA	100	1.8E+04
Carbazole	NA	5	3.4E+00
Carbon Disulfide	700	NA	1.0E+03
Carbon Tetrachloride	1	NA	1.7E-01
Chlorobenzene	50	NA	1.1E+02
Chlorodibromomethane	1	NA	1.3E-01
Chloroethane	NA	100	4.6E+00
Chloroform	70	NA	1.7E-01
Chloromethane	NA	100	1.6E+02
Chrysene	5	NA	9.2E+00
Cis-1,2-Dichloroethene	70	NA	6.1E+01
Cis-1,3-Dichloropropene	1	NA	NA
Cyclohexane	NA	100	1.0E+04
Delta-BHC	NA	5	NA
Dibenzo(a,h)anthracene	0.3	NA	9.2E-03
Dibenzofuran	NA	100	1.2E+01
Dichlorodifluoromethane	1000	NA	3.9E+02
Dieldrin	0.03	NA	4.2E-03
Diethyl Phthalate	6000	NA	2.9E+04
Dimethyl Phthalate	NA	100	3.6E+05
Di-n-butyl Phthalate	NA	100	3.6E+03
Di-n-octyl Phthalate	100	NA	1.5E+03
Endosulfan I	40	NA	2.2E+02
Endosulfan II	40	NA	2.2E+02
Endosulfan Sulfate	40	NA	NA
Endrin	2	NA	1.1E+01
Endrin Aldehyde	NA	100	NA
Endrin Ketone	NA	100	NA
Ethylbenzene	700	NA	1.3E+03
Fluoranthene	300	NA	1.5E+03

TABLE 4-7

Groundwater Screening Criteria  
 Quanta Resources Superfund Site, OU1  
 Edgewater, New Jersey

Parameter	New Jersey Class IIA Groundwater Quality Criterion* (ug/L)	New Jersey Interim Generic Groundwater Quality Criteria (ug/L)	EPA Region 9 Tap Water Preliminary Remediation Goal (ug/L)
Fluorene	300	NA	2.4E+02
Gamma-BHC (Lindane)	0.03	NA	5.2E-02
Heptachlor	0.05	NA	1.5E-02
Heptachlor Epoxide	0.2	NA	7.4E-03
Hexachlorobenzene	0.02	NA	4.2E-02
Hexachlorobutadiene	1	NA	8.6E-01
Hexachlorocyclopentadiene	40	NA	2.2E+02
Hexachloroethane	7	NA	4.8E+00
Indeno(1,2,3-cd)pyrene	0.2	NA	9.2E-02
Iron	300	NA	1.1E+04
Isophorone	40	NA	7.1E+01
Isopropylbenzene	NA	100	6.6E+02
Lead	5	NA	NS
Methoxychlor	40	NA	1.8E+02
Methyl Acetate	7000	NA	6.1E+03
Methyl Tert-butyl Ether (MTBE)	70	NA	1.1E+01
Methylcyclohexane	NA	100	5.2E+03
Methylene chloride	3	NA	4.3E+00
Monomethylarsonic acid (MMA)	NA	100	NA
Naphthalene	300	NA	6.2E+00
Nitrobenzene	6	NA	3.4E+00
Nitrogen, Total Kjeldahl	NA	NA	NA
n-Nitroso-di-n-propylamine	10	NA	9.6E-03
n-Nitrosodiphenylamine	10	NA	1.4E+01
o-Xylene	1000	NA	2.1E+02
Pentachlorophenol	0.3	NA	5.6E-01
Phenanthrene	NA	100	NA
Phenol	2000	NA	1.1E+04
Pyrene	200	NA	1.8E+02
Styrene	100	NA	1.6E+03
Tetrachloroethene	1	NA	1.0E-01
Toluene	1000	NA	7.2E+02
Toxaphene	2	NA	6.1E-02
Trans-1,2-Dichloroethene	100	NA	1.2E+02
Trans-1,3-Dichloropropene	1	NA	NA
Trichloroethene	1	NA	2.8E-02
Trichlorofluoromethane	2000	NA	1.3E+03
Vinyl chloride	1	NA	2.0E-02
Xylenes, m & p	1000	NA	2.1E+02
Xylenes, Total	1000	NA	2.1E+02

## Notes:

\*Value is the higher of the practical quantitation limit (PQL) and the groundwater quality criterion.

NA - No Applicable Standard

PRG - Preliminary Remediation Goal

## Sources:

New Jersey Groundwater Quality Standards: <http://www.state.nj.us/dep/wms/bwqsa/docs/njac79C.pdf>, accessed March 13, 2007.

USEPA Region 9 PRG Table: <http://www.epa.gov/region09/waste/sfund/prg/files/04prgtable.pdf>, accessed March 13, 2007.

**Table 4-8**

Constituents of Interest in Groundwater  
*Quanta Resources Superfund Site, OU1*  
*Edgewater, New Jersey*

Parameter	Lowest Criteria (ug/L)		Number of Locations Sampled	Number of Locations in which Parameter was Detected	Number of Locations Exceeding Screening Criterion	Exceedance Rate	Maximum Detected Concentration (µg/L)
<b>Inorganics</b>							
Ammonia	NJ Class IIA GWQC	3000	18	18	13	72.2%	24100
Arsenic	Region 9 Tap Water PRG	0.045	71	68	68	95.8%	1590000
Arsenic (III)	Region 9 Tap Water PRG	0.045	14	13	13	92.9%	1830000
Arsenic (V)	Region 9 Tap Water PRG	0.045	14	5	5	35.7%	9500
Iron	NJ Class IIA GWQC	300	14	13	13	92.9%	401000
Lead	NJ Class IIA GWQC	5	57	51	17	29.8%	4100
<b>VOCs</b>							
1,1-Dichloroethane	NJ Class IIA GWQC	50	57	10	1	1.8%	120
1,1-Dichloroethene	NJ Class IIA GWQC	1	57	5	2	3.5%	4
1,2,4-Trichlorobenzene	Region 9 Tap Water PRG	7.2	57	4	1	1.8%	13
1,2-Dichloroethane	Region 9 Tap Water PRG	0.12	57	3	3	5.3%	2.9
1,2-Dichloropropane	Region 9 Tap Water PRG	0.16	57	1	1	1.8%	0.3
1,4-Dichlorobenzene	Region 9 Tap Water PRG	0.5	57	2	2	3.5%	2.5
Benzene	Region 9 Tap Water PRG	0.35	57	47	41	71.9%	11000
Chloroethane	Region 9 Tap Water PRG	4.6	57	9	2	3.5%	8
Chloroform	Region 9 Tap Water PRG	0.17	57	6	5	8.8%	1.7
Ethylbenzene	NJ Class IIA GWQC	700	57	42	11	19.3%	170
Methylcyclohexane	NJ Interim Generic Criteria	100	57	13	1	1.8%	1300
O-Xylene	Region 9 Tap Water PRG	210	42	20	3	7.1%	704
Styrene	NJ Class IIA GWQC	100	57	4	3	5.3%	610
Tetrachloroethene	Region 9 Tap Water PRG	0.1	57	4	3	5.3%	9.6
Toluene	Region 9 Tap Water PRG	720	57	41	11	19.3%	4800
Trichloroethene	Region 9 Tap Water PRG	0.028	57	10	10	17.5%	460
Vinyl chloride	Region 9 Tap Water PRG	0.02	57	3	3	5.3%	4.4
Xylenes, m & p	Region 9 Tap Water PRG	210	42	21	4	9.5%	1210
Xylenes, total	Region 9 Tap Water PRG	210	57	44	19	33.3%	3900
<b>PAHs</b>							
2-Methylnaphthalene	NJ Interim Generic Criteria	100	57	39	18	31.6%	8400
Acenaphthene	Region 9 Tap Water PRG	370	57	49	4	7.0%	3300
Acenaphthylene	NJ Interim Generic Criteria	100	57	33	5	8.8%	550
Benzo(a)anthracene	Region 9 Tap Water PRG	0.092	57	32	32	56.1%	1100
Benzo(a)pyrene	Region 9 Tap Water PRG	0.0092	57	14	14	24.6%	800
Benzo(b)fluoranthene	Region 9 Tap Water PRG	0.092	57	17	17	29.8%	920
Benzo(g,h,i)perylene	NJ Interim Generic Criteria	100	57	8	2	3.5%	420
Benzo(k)fluoranthene	Region 9 Tap Water PRG	0.92	57	7	6	10.5%	450
Chrysene	NJ Class IIA GWQC	5	57	24	4	7.0%	1000
Dibenzo(a,h)anthracene	Region 9 Tap Water PRG	0.0092	57	6	6	10.5%	41
Fluoranthene	NJ Class IIA GWQC	300	57	50	2	3.5%	3400
Fluorene	Region 9 Tap Water PRG	240	57	46	3	5.3%	2800
Indeno(1,2,3-cd)pyrene	Region 9 Tap Water PRG	0.092	57	8	8	14.0%	390

**Table 4-8**

Constituents of Interest in Groundwater  
*Quanta Resources Superfund Site, OU1*  
*Edgewater, New Jersey*

Parameter	Lowest Criteria (ug/L)	Number of Locations Sampled	Number of Locations in which Parameter was Detected	Number of Locations Exceeding Screening Criterion	Exceedance Rate	Maximum Detected Concentration (µg/L)
Naphthalene	Region 9 Tap Water PRG 6.2	57	51	38	66.7%	36000
Phenanthrene	NJ Interim Generic Criteria 100	57	48	13	22.8%	8300
Pyrene	Region 9 Tap Water PRG 180	57	48	3	5.3%	2800
<b>SVOCs</b>						
1,1'-Biphenyl	Region 9 Tap Water PRG 300	57	35	1	1.8%	1100
2,4-Dimethylphenol	NJ Class IIA GWQC 100	57	31	16	28.1%	7400
2-Methylphenol*	Region 9 Tap Water PRG 1800	57	27	9	15.8%	4200
3&4-Methylphenol	NJ Interim Generic Criteria 5	42	10	7	16.7%	68.6
4-Methylphenol*	Region 9 Tap Water PRG 180	52	26	9	17.3%	5800
Bis(2-ethylhexyl)phthalate	NJ Class IIA GWQC 3	57	5	1	1.8%	43
Caprolactam	NJ Interim Generic Criteria 100	57	15	1	1.8%	140
Carbazole*	Region 9 Tap Water PRG 3.4	57	42	39	68.4%	790
Dibenzofuran*	Region 9 Tap Water PRG 12	57	43	28	49.1%	2200
Nitrobenzene	Region 9 Tap Water PRG 3.4	57	1	1	1.8%	8
Phenol	NJ Class IIA GWQC 2000	57	20	2	3.5%	3100
<b>Pesticides and PCBs</b>						
4,4'-DDD	Region 9 Tap Water PRG 0.28	12	5	1	8.3%	0.17
4,4'-DDE	Region 9 Tap Water PRG 0.2	12	8	1	8.3%	0.13
Aldrin	Region 9 Tap Water PRG 0.004	12	1	1	8.3%	0.032
Alpha-BHC	Region 9 Tap Water PRG 0.011	12	2	2	16.7%	0.048
Aroclor-1260	Region 9 Tap Water PRG 0.034	57	1	1	1.8%	6.1
Heptachlor	Region 9 Tap Water PRG 0.015	12	3	1	8.3%	0.016

**Notes:**

All concentrations are presented in micrograms per liter (µg/L).

\* This constituent was screened against EPA Region 9 Tap Water PRGs rather than the NJ Interim Generic Criteria. A NJ Class IIA GWQC is not available for this constituent.

New Jersey GW Criteria <http://www.state.nj.us/dep/wms/bwqsa/docs/njac79C.pdf>, accessed March 13, 2007  
 Region 9 PRGs <http://www.epa.gov/region09/waste/sfund/prg/files/04prgtable.pdf>, accessed March 13, 2007  
 Carcinogenicity Chemicals Evaluated for Carcinogenic Potential, Science Information Branch, Health Effects Division, Office of Pesticides Programs, US EPA  
<http://www.pestmanagement.rutgers.edu/NJinPAS/postings/EPAcancerevalchem704.pdf>, accessed March 13, 2007  
 Report on Carcinogens, Eleventh Edition, U.S. Department of Health and Human Services, Public Health Service, National Toxicity Program  
<http://ntp.niehs.nih.gov/ntp/roc/toc11.html>, accessed March 13, 2007



TABLE 4-9

Statistical Comparison of Black/Brown Slag-Rich Fill and Reddish-Purple Soil:  
 Characterization of Cinder/ Ash and Reddish-Purple Soils:  
*Quanta Resources Superfund Site, OUI*  
*Edgewater, New Jersey*

Inorganic	Type	Shapiro-Wilks Test for Normality <sup>a</sup>				Equality of Variance <sup>a,b</sup>			Background Comparison <sup>a,c</sup>							
		Untransformed Data Normal?	p-value	Log-transformed Data Normal?	p-value	Equal Variance?	F Value	p-value	Mann-Whitney Statistic	p-value	t Value	p-value	Significantly Different?			
Aluminum	Brown/Black Slag-Rich Fill	No	0.01481186	No	0.01299926	NA			25	0.00261048	NA		Yes; Slag-Rich Fill greater			
	Reddish-Purple Soils	Yes	0.0935318	Yes	0.55600865				40	0.00536629				Yes; Reddish-Purple Soils greater		
Antimony	Brown/Black Slag-Rich Fill	No	2.0264E-08	No	0.01732947										4	2.3642E-05
	Reddish-Purple Soils	No	0.00055339	Yes	0.90920939				74	0.32230711		-0.95631389	0.34586748			
Arsenic	Brown/Black Slag-Rich Fill	No	4.7391E-14	No	3.4229E-07										Yes	1.17401975
	Reddish-Purple Soils	Yes	0.09750767	Yes	0.71528767				No	6.11314267	0.00076897		NA			
Barium	Brown/Black Slag-Rich Fill	No	9.54E-07	Yes	0.81170957	Yes	1.65325319	0.55099636							NA	0.9227346
	Reddish-Purple Soils	Yes	0.42704108	Yes	0.72923378				No	6.11314267	0.00076897		NA			
Beryllium	Brown/Black Slag-Rich Fill	No	4.968E-10	Yes	0.29071036	Yes	1.65325319	0.55099636							NA	0.9227346
	Reddish-Purple Soils	Yes	0.71115534	Yes	0.11887512				No	6.11314267	0.00076897		NA			
Calcium	Brown/Black Slag-Rich Fill	No	6.3296E-05	Yes	0.63088176	No	6.11314267	0.00076897							74	0.32230711
	Reddish-Purple Soils	No	0.02835286	Yes	0.2731844				Yes	1.2956213	0.57121125	NA	-1.94936689	0.05828742		
Cadmium	Brown/Black Slag-Rich Fill	No	2.3269E-10	Yes	0.08260478	Yes	1.2956213	0.57121125								NA
	Reddish-Purple Soils	No	0.02037955	Yes	0.53090292				No	5.74237916	0.00044318	50	0.0063127	Yes; Slag-Rich Fill greater		
Chromium	Brown/Black Slag-Rich Fill	No	0.00014659	Yes	0.87964932	No	5.74237916	0.00044318								50
	Reddish-Purple Soils	No	5.2357E-05	Yes	0.69640167				No	7.03008042	0.0190658	14	0.45934179	No		
Chromium III	Brown/Black Slag-Rich Fill	No	0.00169266	Yes	0.11869738	No	7.03008042	0.0190658								14
	Reddish-Purple Soils	Yes	0.10522104	Yes	0.7914572				No	5.38937298	0.00181042	56	0.08327414	No		
Cobalt	Brown/Black Slag-Rich Fill	No	0.00212548	Yes	0.66749381	No	5.38937298	0.00181042								56
	Reddish-Purple Soils	Yes	0.48922026	Yes	0.07195313				48	0.0119293		Yes; Reddish-Purple Soils greater				
Copper	Brown/Black Slag-Rich Fill	No	0.0058937	No	0.04815368	NA								48	0.0119293	Yes; Reddish-Purple Soils greater
	Reddish-Purple Soils	Yes	0.4143945	Yes	0.08274199				26	0.00298768		Yes; Reddish-Purple Soils greater				
Iron	Brown/Black Slag-Rich Fill	No	0.00160294	No	2.2518E-11	NA								26	0.00298768	Yes; Reddish-Purple Soils greater
	Reddish-Purple Soils	Yes	0.06600032	Yes	0.25590905				60	0.00228408		Yes; Reddish-Purple Soils greater				
Lead	Brown/Black Slag-Rich Fill	No	1.8071E-08	No	1.8824E-11	Yes	2.08409795	0.16383611						NA		-2.20086423
	Reddish-Purple Soils	No	0.00030582	Yes	0.57914884				Yes	1.34764127	0.54210572	NA	-1.02116378			
Potassium	Brown/Black Slag-Rich Fill	Yes	0.08255504	Yes	0.50665026	Yes	1.34764127	0.54210572						NA		-1.02116378
	Reddish-Purple Soils	Yes	0.0904691	Yes	0.78748677				Yes	1.02642049	1	NA	2.68519792			
Manganese	Brown/Black Slag-Rich Fill	No	2.9153E-06	Yes	0.27120191	Yes	1.02642049	1						NA		2.68519792
	Reddish-Purple Soils	No	0.0287512	Yes	0.84458885				17	0.00083758		NA				
Magnesium	Brown/Black Slag-Rich Fill	No	0.00155581	No	0.04808964	NA								17	0.00083758	NA
	Reddish-Purple Soils	Yes	0.24195239	Yes	0.39277178				41	0.00595156		Yes; Slag-Rich Fill greater				
Nickel	Brown/Black Slag-Rich Fill	No	7.8317E-12	No	0.00207739	Yes	1.46586137	0.66926035						NA		-1.51738706
	Reddish-Purple Soils	No	2.7593E-05	Yes	0.2584965				No	3.31166947	0.02247839	26.5	0.00119653			
Sodium	Brown/Black Slag-Rich Fill	No	4.4144E-06	Yes	0.98473659	Yes	1.46586137	0.66926035						NA		-1.51738706
	Reddish-Purple Soils	Yes	0.37842966	Yes	0.68010482				No	3.31166947	0.02247839	26.5	0.00119653			
Selenium	Brown/Black Slag-Rich Fill	No	1.8354E-10	Yes	0.07173901	No	3.31166947	0.02247839						26.5	0.00119653	Yes; Reddish-Purple Soils greater
	Reddish-Purple Soils	No	1.9699E-05	Yes	0.11295668				81	0.16133629		NA				
Silver	Brown/Black Slag-Rich Fill	No	0.00452152	No	0.0022412	NA								81	0.16133629	NA
	Reddish-Purple Soils	No	0.00349502	No	0.01869401				27.5	0.00152432		Yes; Reddish-Purple Soils greater				
Thallium	Brown/Black Slag-Rich Fill	No	7.0795E-09	No	0.00056666	Yes	2.67004311	0.07279624						NA		2.74102017
	Reddish-Purple Soils	Yes	0.14272546	Yes	0.23549889				No	4.55601188	0.00343315	94	0.33612016			
Vanadium	Brown/Black Slag-Rich Fill	Yes	0.33752499	Yes	0.08930724	Yes	2.67004311	0.07279624						NA		2.74102017
	Reddish-Purple Soils	No	0.02516506	Yes	0.85261184				No	4.55601188	0.00343315	94	0.33612016			
Zinc	Brown/Black Slag-Rich Fill	No	1.3483E-05	Yes	0.38075098	No	4.55601188	0.00343315						94	0.33612016	NA
	Reddish-Purple Soils	Yes	0.0512526	Yes	0.6777497											

## Notes:

Non-detects were included at 1/2 the detection limit

NA = Data (untransformed or transformed) used for comparisons; data with closest approximation to normal distribution and greatest equality of variance (based on p-values) selected; Untransformed data used for non-parametric tests.

NA = Test not performed

<sup>a</sup> p-values were considered significant at  $p \leq 0.05$

<sup>b</sup> An equality of variance test was performed only if both data sets had normal distributions

<sup>c</sup> A t-test comparison was made only if both data sets were normal and had equal variances, otherwise a non-parametric Mann-Whitney rank-sum test was performed

**TABLE 4-10**

Groundwater Data Results Summary for Arsenic and Nitrogen Parameters, August /October 2006

*Quanta Resources Superfund Site, OU1**Edgewater, New Jersey*

Well	Total As/ Speciation Sample Date	MMA/DMA, Ammonia and TKN Sample Date	Arsenic Parameters (micrograms per liter)					Nitrogen Parameters (milligrams per liter)			
			Arsenic (Total)	Arsenic (III)	Arsenic (V)	MMA	DMA	Ammonia	TKN	Organic Nitrogen	% of TKN that is Organic Nitrogen
MW-107A	8/17/06	10/26/06	18900 J	30700	8000 U	30 U	52 U	7	21.7	14.7	68%
MW-109A	8/17/06	10/26/06	288	193	174	0.059 U	0.11 U	2.9	8.2	5.3	65%
MW-111B	8/22/06	10/26/06	59800 J	112000	16000 U	30 U	52 U	4.1	9.7	5.6	58%
MW-113B	8/22/06	10/24/06	12400	15500	9500	0.483 J	0.753 J	10.1	21.4	11.3	53%
MW-114B	8/26/06	10/26/06	3810	2980	800 U	0.938 J	0.11 UJ	10.5	12.2	1.7	14%
MW-36	8/17/06	10/26/06	3260	2 U	100 U	0.779 J	0.11 U	5.2	13.2	8	61%
MW-A-2	8/24/06	10/25/06	95800	136000	32000 U	35 J	52 U	4.4	12.9	8.5	66%
MW-B	8/24/06	10/24/06	992	448	212	0.237 J	0.523 J	2.9	7.2	4.3	60%
MW-C	8/24/06	10/24/06	987	23.1	4.8	0.261 J	0.04 U	3	7.9	4.9	62%
MW-F	8/24/06	10/24/06	107	119	32 U	0.02 U	0.04 U	3.5	8.8	5.3	60%
MW-L	8/24/06	10/26/06	321	13.1	12.7	0.059 UJ	0.11 UJ	3.1	3.2	0.1	3%
MW-N-1	10/25/06	10/25/06	1590000	1830000	269000 U	30 U	52 U	16.1	40.6	24.5	60%
MW-N-2	10/25/06	10/25/06	17900	24300	16800 U	30 U	52 U	0.98	3.7	2.72	74%
MW-O	10/25/06	10/25/06	214	23.9	8 U	0.148 J	0.11 U	7	18	11	61%
MW-O (dup)	10/25/06	10/25/06	216	23.5	8 U	0.066 J	0.11 U	7.2	18.7	11.5	61%
MW-101A	8/21/06	NS	40.6	---	---	---	---	---	---	---	---
MW-101DS	8/21/06	NS	2 U	---	---	---	---	---	---	---	---
MW-103A	8/22/06	NS	4.7	---	---	---	---	---	---	---	---
MW-103DS	8/22/06	NS	2.9	---	---	---	---	---	---	---	---
MW-106	8/15/06	NS	5.1 U	---	---	---	---	---	---	---	---
MW-106A	8/16/06	NS	5.5 U	---	---	---	---	---	---	---	---
MW-107DS	8/18/06	NS	12.7	---	---	---	---	---	---	---	---
MW-108	8/18/06	NS	3.4 U	---	---	---	---	---	---	---	---
MW-109	8/17/06	NS	32.3	---	---	---	---	---	---	---	---
MW-111A	8/21/06	NS	48400	---	---	---	---	---	---	---	---
MW-113A	8/21/06	NS	923	---	---	---	---	---	---	---	---
MW-113C	8/21/06	NS	6210	---	---	---	---	---	---	---	---
MW-114A	8/19/06	NS	8.7	---	---	---	---	---	---	---	---
MW-115A	8/15/06	NS	74.1	---	---	---	---	---	---	---	---
MW-115B	8/15/06	NS	40 U	---	---	---	---	---	---	---	---
MW-116DS	8/22/06	NS	2 U	---	---	---	---	---	---	---	---
MW-117B	8/23/06	NS	2 U	---	---	---	---	---	---	---	---
MW-118A	8/23/06	NS	14.5 U	---	---	---	---	---	---	---	---
MW-119B	8/19/06	NS	4 U	---	---	---	---	---	---	---	---
MW-120A	8/15/06	NS	2 U	---	---	---	---	---	---	---	---
MW-120B	8/15/06	NS	2.3 U	---	---	---	---	---	---	---	---
MW-121A	8/19/06	NS	9.5	---	---	---	---	---	---	---	---
MW-122A	8/18/06	NS	15300	---	---	---	---	---	---	---	---
MW-29	8/16/06	NS	6 U	---	---	---	---	---	---	---	---
MW-31	8/16/06	NS	172	---	---	---	---	---	---	---	---

**TABLE 4-10**

Groundwater Data Results Summary for Arsenic and Nitrogen Parameters, August /October 2006

*Quanta Resources Superfund Site, OU1**Edgewater, New Jersey*

Well	Total As/ Speciation Sample Date	MMA/DMA, Ammonia and TKN Sample Date	Arsenic Parameters (micrograms per liter)					Nitrogen Parameters (milligrams per liter)			
			Arsenic (Total)	Arsenic (III)	Arsenic (V)	MMA	DMA	Ammonia	TKN	Organic Nitrogen	% of TKN that is Organic Nitrogen
MW-32	8/17/06	NS	1540	---	---	---	---	---	---	---	---
MW-4	8/18/06	NS	305	---	---	---	---	---	---	---	---
MW-A-1	8/23/06	NS	5530	---	---	---	---	---	---	---	---
MW-G	8/23/06	NS	11.9	---	---	---	---	---	---	---	---
MW-I	8/23/06	NS	9.2	---	---	---	---	---	---	---	---
MW-J	8/23/06	NS	152	---	---	---	---	---	---	---	---
ACMW-1	10/26/06	NS	20 U	---	---	---	---	---	---	---	---
ACMW-3	10/27/06	NS	2.6	---	---	---	---	---	---	---	---
DMW-2	10/23/06	NS	3.6	---	---	---	---	---	---	---	---
MW-20	10/26/06	NS	102	---	---	---	---	---	---	---	---
MW-22A	10/27/06	NS	10.4	---	---	---	---	---	---	---	---
MW-36EE	10/23/06	NS	4.5	---	---	---	---	---	---	---	---
MW-E	10/25/06	NS	31.8 U	---	---	---	---	---	---	---	---
MW-H	10/26/06	NS	22.2	---	---	---	---	---	---	---	---
MW-K	10/27/06	NS	27.1	---	---	---	---	---	---	---	---
MW-M	10/26/06	NS	2.3	---	---	---	---	---	---	---	---
MW-N-3	10/26/06	NS	4.1	---	---	---	---	---	---	---	---

**Notes:**

Total Arsenic in groundwater analyzed using EPA Method SW6010

Arsenic III and IV in groundwater analyzed using EPA Method SW7063

Samples were not field filtered

Ammonia analzed using EPA Method E350.1

Ammonium is a primary nutrient for microbial activity and growth in population. The combination of ammonia and organic forms of nitrogen comprise total kjeldahl nitrogen (TKN). Organic nitrogen is generated by microbial enzymatic processes and therefore reflects the relative amount of microbial activity in the aquifer. This organic form of nitrogen is calculated by subtracting the ammonia nitrogen from the TKN.

DMA - Dimethylarsinic Acid or Cacodylic Acid (EPA Method SW6800)

J - Concentration is estimated

MMA - Monomethylarsonic acid (EPA Method SW6800)

NS - Indicates this parameter was not sampled for

TKN - Total Kjeldhal Nitrogen (EPA Method E351.2)

U - Constituent was not detected

**Table 5-1**  
Physical and Chemical Properties of Representative Organic Constituents of Interest  
*Quanta Resources Superfund Site*  
*Edgewater, New Jersey*

Representative Constituents of Interest	CAS Number	Molecular Formula <sup>1</sup>	Molecular Weight <sup>1</sup>	Specific Gravity (20°C)	Aqueous Solubility (20-25°C) (mg/L)	Organic Carbon Partition Coefficient (Koc) (cm3/g)	Vapor Pressure (as mm of Hg at 25°C) <sup>1</sup>	Henry's Law Constant (atm-m <sup>3</sup> /mol)
<b>PAHs</b>								
2-Methylnaphthalene	91-57-6	C <sub>11</sub> H <sub>10</sub>	142.0	1.006 (4)	2.46E+01 (5)	2.45E+03 (5)	6.81E-02 (1)	4.99E-04 (5)
Acenaphthene	83-32-9	C <sub>12</sub> H <sub>10</sub>	154.2	1.024 (90°C/4°C) (5)	4.24E+00 (3)	4.90E+03 (3)	2.50E-03 (1)	1.6E-04 (3)
Acenaphthylene	208-96-8	C <sub>12</sub> H <sub>8</sub>	152.2	0.899 (61 °F) (4)	1.61E+01 (1)	9.47E+02 (1)	9.12E-04 (1)	1.13E-05 (1)
Anthracene	120-12-7	C <sub>14</sub> H <sub>10</sub>	178.2	1.24 (4)	4.34E-02 (2)	2.95E+04 (2)	2.67E-06 (1)	6.51E-05 (2)
Benzo(a)anthracene	56-55-3	C <sub>18</sub> H <sub>12</sub>	228.3	No data (5)	9.40E-03 (2)	3.98E+05 (2)	3.05E-08 (1)	3.34E-06 (2)
Benzo(a)pyrene	50-32-8	C <sub>20</sub> H <sub>12</sub>	252.3	No data (5)	1.62E-03 (2)	1.02E+06 (2)	5.49E-09 (1)	1.13E-06 (2)
Benzo(b)fluoranthene	205-99-2	C <sub>20</sub> H <sub>12</sub>	252.3	No data (5)	1.50E-03 (2)	1.23E+06 (2)	5.00E-07 (1)	1.11E-04 (2)
Benzo(g,h,i)perylene	191-24-2	C <sub>22</sub> H <sub>12</sub>	276.3	No data (5)	2.60E-04 (5)	4.06E+05 (3)	1.01E-10 (1)	1.41E-07 (3)
Benzo(k)fluoranthene	207-08-9	C <sub>20</sub> H <sub>12</sub>	252.3	No data (5)	8.00E-04 (2)	1.23E+06 (2)	2.00E-09 (1)	8.29E-07 (2)
Chrysene	218-01-9	C <sub>18</sub> H <sub>12</sub>	228.3	1.274 (4)	1.60E-03 (2)	3.98E+05 (2)	6.23E-09 (1)	9.46E-05 (2)
Dibenzo(a,h)anthracene	53-70-3	C <sub>22</sub> H <sub>14</sub>	278.4	1.282 (4)	2.49E-03 (2)	3.80E+06 (2)	1.00E-10 (1)	1.47E-08 (2)
Fluoranthene	206-44-0	C <sub>16</sub> H <sub>10</sub>	202.3	1.252 (32 °F) (4)	2.06E-01 (2)	1.07E+05 (2)	1.23E-08 (1)	1.61E-05 (2)
Fluorene	86-73-7	C <sub>13</sub> H <sub>10</sub>	166.2	1.203 (32 °F) (4)	1.98E+00 (2)	1.38E+04 (2)	8.42E-03 (1)	6.37E-05 (2)
Indeno(1,2,3-cd)pyrene	193-39-5	C <sub>22</sub> H <sub>12</sub>	276.3	No data (5)	2.20E-05 (2)	3.47E+06 (2)	1.0 E-10 (20°C) (1)	1.60E-06 (2)
Naphthalene	91-20-3	C <sub>10</sub> H <sub>8</sub>	128.2	1.150 (4)	3.01E+01 (2)	2.00E+03 (2)	8.50E-02 (1)	4.83E-04 (2)
Phenanthrene	85-01-8	C <sub>14</sub> H <sub>10</sub>	178.2	1.025 (4)	1.15E+00 (3)	2.30E+04 (1)	1.12E-04 (1)	2.33E-05 (3)
Pyrene	129-00-0	C <sub>16</sub> H <sub>10</sub>	202.3	1.270 (73.4 °F) (4)	1.35E-01 (2)	1.05E+05 (2)	2.45E-06 (1)	1.10E-05 (2)
<b>Non-PAH SVOCs</b>								
1,1'-Biphenyl	92-52-4	C <sub>12</sub> H <sub>10</sub>	154.2	0.992 (4)	7.5E+00 (3)	7.8E+03 (3)	9.64E-03 (1)	3.0E-04 (3)
2,4-Dimethylphenol	105-67-9	C <sub>8</sub> H <sub>10</sub> O	122.2	1.028 (57.0 ° F) (4)	7.87E+03 (2)	2.09E+02 (2)	9.80E-02 (1)	2.00E-06 (2)
2,4-Dinitrotoluene	121-14-2	C <sub>7</sub> H <sub>6</sub> N <sub>2</sub> O <sub>4</sub>	182.2	1.379 (4)	2.70E+02 (2)	9.55E+01 (2)	1.47E-04 (1)	9.27E-08 (2)
2-Methylphenol	95-48-7	C <sub>7</sub> H <sub>8</sub> O	108.9	1.047 (4)	2.60E+04 (2)	9.12E+01 (2)	2.99E-01 (1)	1.20E-06 (2)
3&4-Methylphenol	No data	No data	No data	No data	No data	No data	No data	No data
4-Methylphenol	No data	No data	No data	No data	No data	No data	No data	No data
4-Nitroaniline	No data	No data	No data	No data	No data	No data	No data	No data
Bis(2-ethylhexyl)phthalate	117-81-7	C <sub>24</sub> H <sub>38</sub> O <sub>4</sub>	390.5	0.980 (77.0 ° F) (4)	3.40E-01 (2)	1.51E+07 (2)	6.78E-08 (1)	1.02E-07 (2)
Caprolactam	105-60-2	C <sub>6</sub> H <sub>11</sub> NO	113.2	1.020 (170.6 ° F) (4)	No data	No data	1.60E-03 (1)	No data
Carbazole	86-74-8	C <sub>12</sub> H <sub>9</sub> N	167.2	1.100 (64.0 ° F) (4)	7.48E+00 (2)	3.39E+03 (2)	7.00E-04 (20°C) (1)	1.53E-08 (2)
Dibenzofuran	132-64-9	C <sub>12</sub> H <sub>8</sub> O	168.2	1.089 (210.0 ° F) (4)	3.1E+00 (3)	7.8E+03 (3)	1.80E-04 (1)	1.3E-05 (3)
Nitrobenzene	98-95-3	C <sub>6</sub> H <sub>5</sub> NO <sub>2</sub>	123.1	1.204 (4)	2.09E+03 (2)	6.46E+01 (2)	2.45E-01 (1)	2.40E-05 (2)
Phenol	108-95-2	C <sub>6</sub> H <sub>6</sub> O	94.1	1.040 (105.8 ° F) (4)	8.28E+04 (2)	2.88E+01 (2)	2.76E-01 (1)	3.98E-07 (2)

**Table 5-1**  
Physical and Chemical Properties of Representative Organic Constituents of Interest  
*Quanta Resources Superfund Site*  
*Edgewater, New Jersey*

Representative Constituents of Interest	CAS Number	Molecular Formula <sup>1</sup>	Molecular Weight <sup>1</sup>	Specific Gravity (20°C)	Aqueous Solubility (20-25°C) (mg/L)	Organic Carbon Partition Coefficient (Koc) (cm3/g)	Vapor Pressure (as mm of Hg at 25°C) <sup>1</sup>	Henry’s Law Constant (atm-m <sup>3</sup> /mol)
<b>Aromatic VOCs</b>								
Benzene	71-43-2	C <sub>6</sub> H <sub>6</sub>	78.1	0.879 (4)	1.75E+03 (2)	5.89E+01 (2)	9.50E+01 (1)	5.56E-03 (2)
Ethylbenzene	100-41-4	C <sub>8</sub> H <sub>10</sub>	106.2	0.867 (4)	1.69E+02 (2)	3.63E+02 (2)	9.60E+00 (1)	7.88E-03 (2)
Methylcyclohexane	108-87-2	C <sub>7</sub> H <sub>14</sub>	98.2	0.770 (4)	1.4E+01 (3)	2.2E+03 (3)	8.33E+01 (4)	4.3E-01 (3)
Styrene	100-42-5	C <sub>8</sub> H <sub>8</sub>	104.2	0.906 (4)	3.1E+02 (3)	7.8E+02 (3)	6.12E+00 (1)	2.8E-03 (3)
Toluene	108-88-3	C <sub>7</sub> H <sub>8</sub>	92.1	0.867 (4)	5.3E+02 (3)	1.8E+02 (3)	2.84E+01 (1)	6.6E-03 (3)
o-Xylene	95-47-6	C <sub>8</sub> H <sub>10</sub>	106.2	0.880 (4)	1.78E+02 (2)	3.63E+02 (2)	6.61E+00 (1)	5.20E-03 (2)
m-Xylene	108-38-3	C <sub>8</sub> H <sub>10</sub>	106.2	0.864 (4)	1.61E+02 (2)	4.07E+02 (2)	8.45E+00 (1)	7.34E-03 (2)
p-Xylene	106-42-3	C <sub>8</sub> H <sub>10</sub>	90.1	0.861 (4)	1.85E+02 (2)	3.89E+02 (2)	8.90E+00 (1)	7.66E-03 (2)
Xylene, mixed isomers	1330-20-7	C <sub>8</sub> H <sub>10</sub>	106.2	0.860 (4)	1.6E+02 (3)	4.1E+02 (3)	6.72E+00 (70.0 ° F) (4)	7.3E-03 (3)
<b>Chlorinated VOCs</b>								
Chloroethane	75-00-3	C <sub>2</sub> H <sub>5</sub> Cl	64.5	0.906 (53.96 ° F) (4)	5.7E+03 (3)	1.5E+01 (3)	1.01E+03 (1)	1.1E-02 (3)
Chloroform	67-66-3	CH <sub>2</sub> Cl <sub>3</sub>	119.4	1.483 (4)	7.92E+03 (2)	3.98E+01 (2)	1.97E+02 (1)	3.66E-03 (2)
1,1-Dichloroethane	75-34-3	C <sub>2</sub> H <sub>4</sub> Cl <sub>2</sub>	99.0	1.174 (4)	5.06E+03 (2)	3.16E+01 (2)	2.27E+02 (1)	5.61E-03 (2)
1,1-Dichloroethene	75-35-4	C <sub>2</sub> H <sub>2</sub> Cl <sub>2</sub>	99.0	1.210 (4)	2.25E+03 (2)	5.89E+01 (2)	6.00E+02 (1)	2.61E-02 (2)
1,2,4-Trichlorobenzene	120-82-1	C <sub>6</sub> H <sub>3</sub> Cl <sub>3</sub>	181.4	1.454 (4)	3.00E+02 (2)	1.78E+03 (2)	4.31E-01 (1)	1.42E-03 (2)
1,2-Dichloroethane	107-06-2	C <sub>2</sub> H <sub>4</sub> Cl <sub>2</sub>	99.0	1.253 (4)	8.52E+03 (2)	1.74E+01 (2)	7.89E+01 (1)	9.78E-04 (2)
1,2-Dichloropropane	78-87-5	C <sub>3</sub> H <sub>6</sub> Cl <sub>2</sub>	113.0	1.158 (4)	2.80E+03 (2)	4.37E+01 (2)	5.20E+01 (1)	2.80E-03 (2)
1,4-Dichlorobenzene	106-46-7	C <sub>6</sub> H <sub>4</sub> Cl <sub>2</sub>	147.0	1.458 (4)	7.38E+01 (2)	6.17E+02 (2)	1.00E+00 (1)	2.43E-03 (2)
Methylene chloride	75-09-2	CH <sub>2</sub> Cl	84.9	1.322 (4)	1.30E+04 (2)	1.17E+01 (2)	4.33E+02 (1)	2.19E-03 (2)
Tetrachloroethene	127-18-4	C <sub>2</sub> Cl <sub>4</sub>	165.8	1.630 (4)	2.00E+02 (2)	1.55E+02 (2)	1.86E+01 (1)	1.84E-02 (2)
Trichloroethene	79-01-6	C <sub>2</sub> HCl <sub>3</sub>	131.4	1.460 (4)	1.10E+03 (2)	1.66E+02 (2)	7.35E+01 (1)	1.03E-02 (2)
Vinyl chloride	75-01-4	C <sub>2</sub> H <sub>3</sub> Cl	62.5	0.969 (8.6 ° F) (4)	2.76E+03 (2)	1.86E+01 (2)	2.98E+03 (1)	2.71E-02 (2)
<b>Pesticides</b>								
Heptachlor	76-44-8	C <sub>10</sub> H <sub>5</sub> Cl <sub>7</sub>	373.3	1.660 (4)	1.80E-01 (2)	1.41E+06 (2)	4.00E-04 (1)	1.09E-03 (2)
Alpha-BHC	319-84-6	C <sub>6</sub> H <sub>6</sub> Cl <sub>6</sub>	290.8	1.870 (4)	2.00E+00 (2)	1.23E+03 (2)	4.50E-05 (1)	1.06E-05 (2)
4,4'-DDD	72-54-8	C <sub>14</sub> H <sub>10</sub> Cl <sub>4</sub>	320.0	1.476 (4)	9.00E-02 (2)	1.00E+06 (2)	6.7E-07 (20°C) (1)	4.00E-06 (2)
4,4'-DDE	72-55-9	C <sub>14</sub> H <sub>8</sub> Cl <sub>4</sub>	318.0	NA	1.20E-01 (2)	4.47E+06 (2)	6.00E-06 (1)	2.10E-05 (2)
Aldrin	309-00-2	C <sub>12</sub> H <sub>8</sub> Cl <sub>6</sub>	364.9	1.700 (4)	1.80E-01 (2)	2.45E+06 (2)	6.00E-06 (1)	1.70E-04 (2)

**Table 5-1**  
Physical and Chemical Properties of Representative Organic Constituents of Interest  
*Quanta Resources Superfund Site*  
*Edgewater, New Jersey*

Representative Constituents of Interest	CAS Number	Molecular Formula <sup>1</sup>	Molecular Weight <sup>1</sup>	Specific Gravity (20°C)	Aqueous Solubility (20-25°C) (mg/L)	Organic Carbon Partition Coefficient (Koc) (cm3/g)	Vapor Pressure (as mm of Hg at 25°C) <sup>1</sup>	Henry’s Law Constant (atm-m <sup>3</sup> /mol)
<b>PCBs</b>								
Aroclors	Mixture	Mixture	326 (approx.) <sup>4</sup>	1.3-1.8 (4)	Insoluble (4)	No data	6.00E-05 (4)	No data
Aroclor-1254	11097-69-1	Mixture	328	No data	0.057 (5)	No data (5)	7.71E-05 (5)	2.00E-03 (5)
Aroclor-1260	11096-82-5	Mixture	357.7	No data	0.080 (5)	No data (5)	4.05E-05 (5)	4.60E-03 (5)
Aroclor-1242	53469-21-9	Mixture	266.5	No data	0.340 (5)	No data (5)	4.06E-04 (5)	5.20E-04 (5)
Aroclor-1248	12672-29-6	Mixture	No data	No data	No data	No data	No data	No data

Notes:  
(1) <http://www.syrres.com/esc/chemfate.htm>  
(2) EPA Soil Screening Levels Guidance  
(3) EPA Region 9 PRG Tables (2004)  
(4) <http://www.cameochemicals.noaa.gov>  
(5) <http://www.atsdr.cdc.gov/toxprofiles/tp67.html#bookmark03>

NA - Not Available

**TABLE 5-2**

Retardation Factor Calculations for Select Organic Compounds  
 Quanta Resources Superfund Site, OU1  
 Edgewater, New Jersey

Hydro-stratigraphic Unit	Organic Constituent of Interest	<sup>1</sup> Koc (ml/g)	<sup>2</sup> Fraction of Organic Carbon (foc)	Calculated Kd (cm <sup>3</sup> /g)	Assumed Soil Bulk Density (pb) (g/cm <sup>3</sup> )	Assumed Porosity (n)	Retardation Factor	<sup>3</sup> Calculated Flow Velocity (ft/day)	Contaminant Transport Velocity (ft/day)	Time to Travel 600 ft (years)
Unconfined	Benzene	58.9	0.04	2.4	1.5	0.25	15	0.55	3.63E-02	45
Unconfined	Naphthalene	1190	0.04	47.6	1.5	0.25	287	0.55	1.92E-03	857
Unconfined	Benzo(a)pyrene	1,020,000	0.04	40800	1.5	0.25	244801	0.55	2.25E-06	731659
Unconfined	Phenol	28.8	0.04	1.152	1.5	0.25	7.9	0.55	6.95E-02	24
Deep Sand	Trichloroethene	166	0.006	1.0	1.5	0.25	7.0	0.02	2.87E-03	573
Deep Sand	Tetrachloroethene	155	0.006	0.9	1.5	0.25	6.6	0.02	3.04E-03	541
Deep Sand	Vinyl Chloride	18.6	0.006	0.11	1.5	0.25	1.7	0.02	1.20E-02	137

Notes:

1 - K<sub>oc</sub> values taken from the U.S. EPA, Supplemental Guidance for Developing Soil Screening Levels for Superfund Sites, Peer Review Draft, OSWER 9355.4-24, March 2001 (Exhibit C-4).

2 - A total of 28 soil samples have been collected and analyzed for Total Organic Carbon (TOC) in the shallow soil as part of remedial investigative efforts associated with the Quanta Resources Superfund Site (including samples collected as recently as June 2007 as part of the Cinder/Ash Investigation. The geometric mean value for foc associated with this combined data set is 0.04 (unitless). For Deep Sand Unit soils which are known to be comprised primarily of clean sands a default foc value of 0.006 was used (U.S. EPA, Supplemental Guidance for Developing Soil Screening Levels for Superfund Sites, Peer Review Draft, OSWER 9355.4-24, March 2001).

3 - The calculation of the linear flow velocities for unconfined and deep sand groundwater is detailed in Section 3.0 of the RI Report.

foc - fraction of organic carbon

ft/day - feet per day

cm<sup>3</sup>/g - cubic centimeters per gram

Kd - adsorption capacity = organic carbon water partition coefficient (Koc) x soil organic carbon content (foc)

koc - organic carbon partition coefficient

mL/g = microgram adsorbed per gram organic carbon (ug/g) per microgram per milliliter (ug/mL) solution

n - soil porosity [assumed 0.25 (unitless)]

Retardation Factor (R) = 1 + (pb/n) x Kd, where:

pb - soil bulk density (assumed 1.5 g/cm<sup>3</sup>)

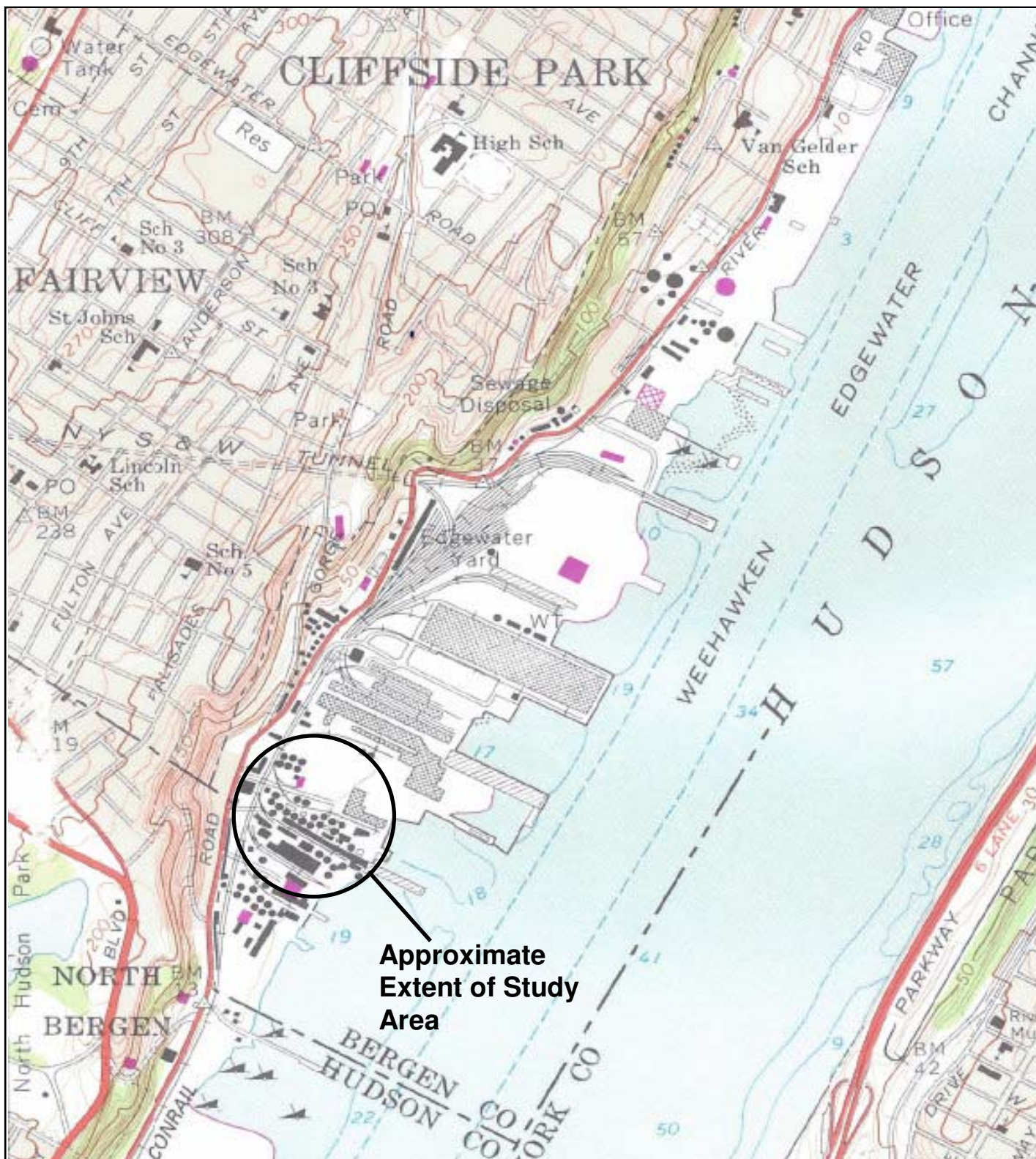
**Table 5-3**  
**TOC Soil Sample Lithology Summary**  
*Quanta Resources Superfund Site, OU1*  
*Edgewater, New Jersey*

Location	Start Depth (ft bgs)	End Depth (ft bgs)	Sampling Date	Soil Description	Lithology	Product	TOC mg/kg
AD-SS-01	0	0.5	12/21/2006	Subrounded/angular gravel to very coarse sand, medium dark gray.	Fill	No	4250
AD-SS-02	0	0.5	12/21/2006	No log.	Fill	No	27700
AD-SS-03	0	0.5	12/21/2006	No log.	Fill	No	3940
AD-SS-04	0	0.5	12/21/2006	No log.	Fill	No	74500
AD-SS-05	0	0.5	12/21/2006	No log.	Fill	No	15200
AD-SS-06	0	0.5	12/21/2006	No log.	Fill	No	49600
AD-SS-07	0	0.5	12/21/2006	No log.	Fill	No	35300
AD-SS-08	0	0.5	12/21/2006	No log.	Fill	No	32500
AD-SS-09	0	0.5	12/21/2006	No log.	Fill	No	27800
AD-SS-10	0	0.5	12/21/2006	No log.	Fill	No	51400
AD-SS-11	0	0.5	12/21/2006	No log.	Fill	No	77200
AD-SS-12	0	0.5	12/21/2006	No log.	Fill	No	47500
SB-28	2.9	3.9	6/5/2007	Fine, angular gravel with little slag, black, dry, loss/medium dense.	Fill	No	305000
	6	7	6/5/2007	Fine, angular gravel/coarse sand, trace silt, trace slag, black, saturated, dense.	Fill	No	300000
SB-30	1.5	3.5	6/5/2007	Very fine sand and angular gravel, dark gray 10YR 4/1, moist, medium dense	Fill	No	47500
	4	15	6/5/2007	4-5' Coarse sand, little fine sand and gravel, some plastic tar, trace brick, trace slag, dark gray 10YR 4/1, moist, medium dense, sheen on groundwater.	Fill	Sheen	80600
				5-10' Fine gravel/coarse sand, some medium sand, little silt, trace slag, dark gray 10YR 2/1, saturated.	Fill	No	
SB-31	0	2.2	6/5/2007	Mix of fine/silty sand and coarse, angular gravel/cobble, very dark brown 7.5YR 2.5/2, dry, medium dense.	Fill	No	204000
	4.5	7.6	6/5/2007	4.5-5' Gravel with little slag, black, saturated, loose.	Fill	No	
				5-7.6' Gravel with little slag, black, saturated, loose with some soft, plastic tar.	Fill	No	
SB-34	0.9	1.6	6/4/2007	Heterogeneous mix of crushed brick, gravel, silt, and sand, medium dense, product odor, little black product, trace/little slag, saturated.	Fill	Yes	147000
SB-36	0.8	1.2	6/6/2007	0.8-1.0' Coarse sand, little gravel, yellowish brown 10YR 5/4, dry.	Fill	No	481000
				1.0-1.2' Fine sand, little coal fragments, trace brick, black, dry.	Fill	No	
	1.2	2.2	6/6/2007	Fine sand, trace coarse sand and gravel, very dusky red, 10R 2.5/2, dry, dense at 1.6' bgs inclusion of pale yellow, fine to coarse crystals (possibly sulfur?)	Fill	No	67900
	3.2	5.2	6/6/2007	Fine sand, trace coarse sand and gravel, trace silt, dusky red, 10R 3/6, mottle with pale yellow 2.5Y 8/3, saturated.	Fill	No	18800
SB-37	3.9	5	6/6/2007	Fine sand, little coal, gravel, coarse sand, brick and cinder/slag, black, saturated.	Fill	No	78100
				Medium sand, little slag, saturated, loose.	Fill	No	
	3.9	5	6/6/2007	Medium sand, little slag, saturated, loose.	Fill	No	102000
SB-38	1.7	3.4	6/6/2007	Fine sand, little coarse sand and gravel, very dark brown grades to reddish brown 2.5YR 4/4, moist, medium dense.	Fill	No	101000
	3.4	7.3	6/6/2007	Coarse sand and gravel, trace silt, dark red 10R 3/6, saturated, loose, from approx. 6.8-7.3 ft bgs black coal tar liquid observed.	Fill	Yes	1940
	9.4	9.6	6/6/2007	Angular gravel, trace fine sand and silt, coal tar, black, saturated.	Fill	Yes	157000
SLG-01	0	0.2	6/4/2007	Slag material.	Fill	No	54600

**Notes:**

ft bgs - feet below ground surface  
mg/kg - milligrams per kilogram  
TOC - total organic carbon





Map Source:  
Central Park, New York – New Jersey  
United States Geological Survey  
7.5 Minute Quadrangle

Topography and photogrammetric  
methods from aerial photographs  
taken in 1954 and planetable  
surveys in 1956. Field checked in  
1966. Revised in 1979 from aerial  
photographs taken in 1977.



CH2MHILL

### Study Area Location Map

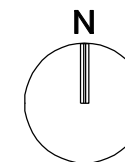
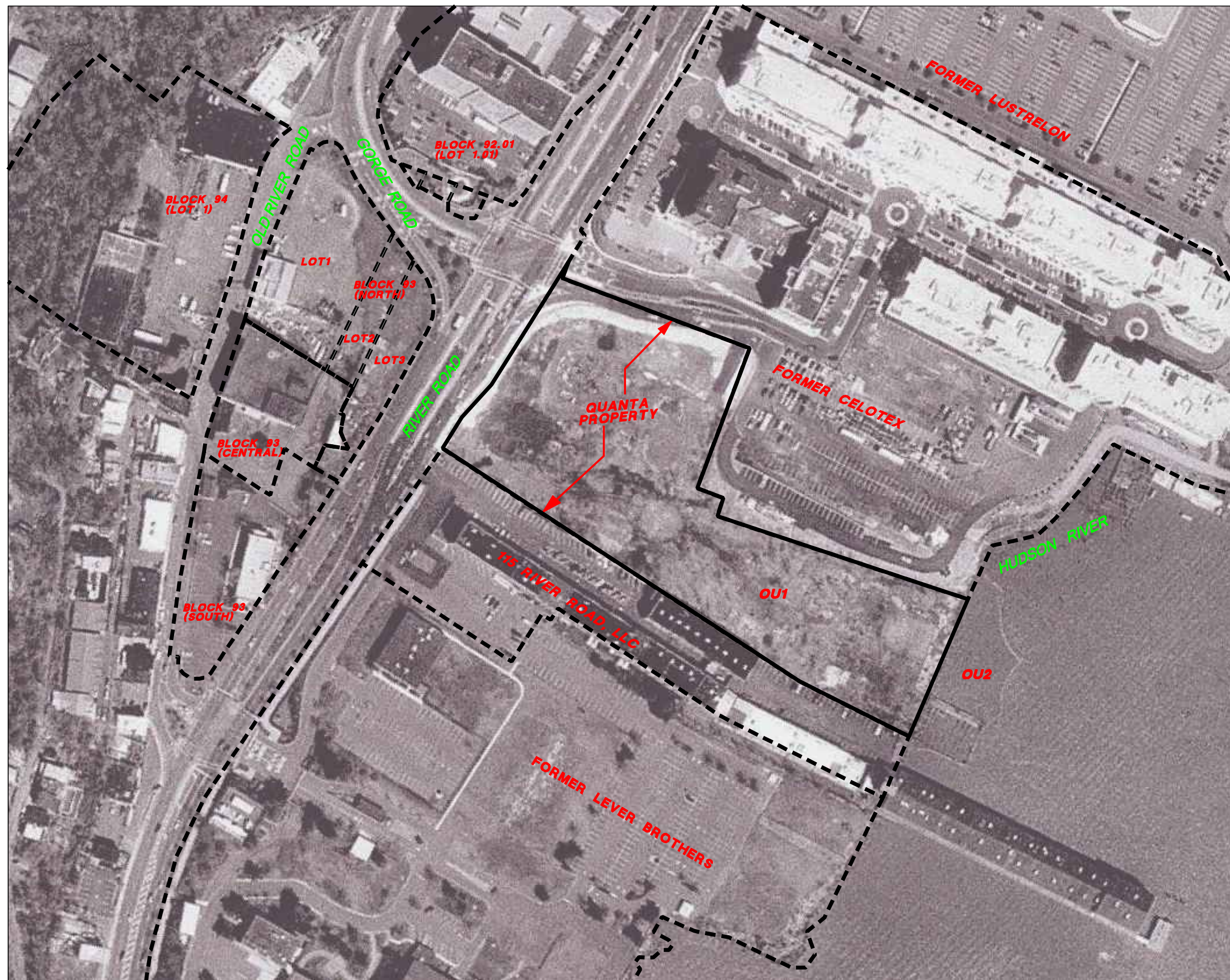
Quanta Resources Superfund Site  
Operable Unit 1  
Edgewater, New Jersey

Nov. 1, 2007

**FIGURE ES-1**

306242



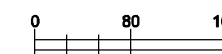


#### LEGEND

--- APPROXIMATE PROPERTY  
BOUNDARIES

#### Notes:

- 1.) Source of Aerial Photograph:  
Aerographics Corporation, 2005. Pic  
No. 20602382S, Frame No. 216. Scale:  
1:3,100, 1 inch - 258 feet. April 16.
- 2.) Approximate property boundaries  
taken from most recent Bergen County  
Tax Maps.
- 3.) For purposes of this figure property  
lines are not extended into the Hudson  
River.



#### PROPERTY LOCATION MAP WITH AERIAL PHOTOGRAPH

Quanta Resources Superfund Site  
Operable Unit 1  
Edgewater, New Jersey

November 1, 2007

FIGURE ES-2



Figure ES-3  
Conceptual Site Model for OU1  
Quanta Resources Site, Edgewater, New Jersey

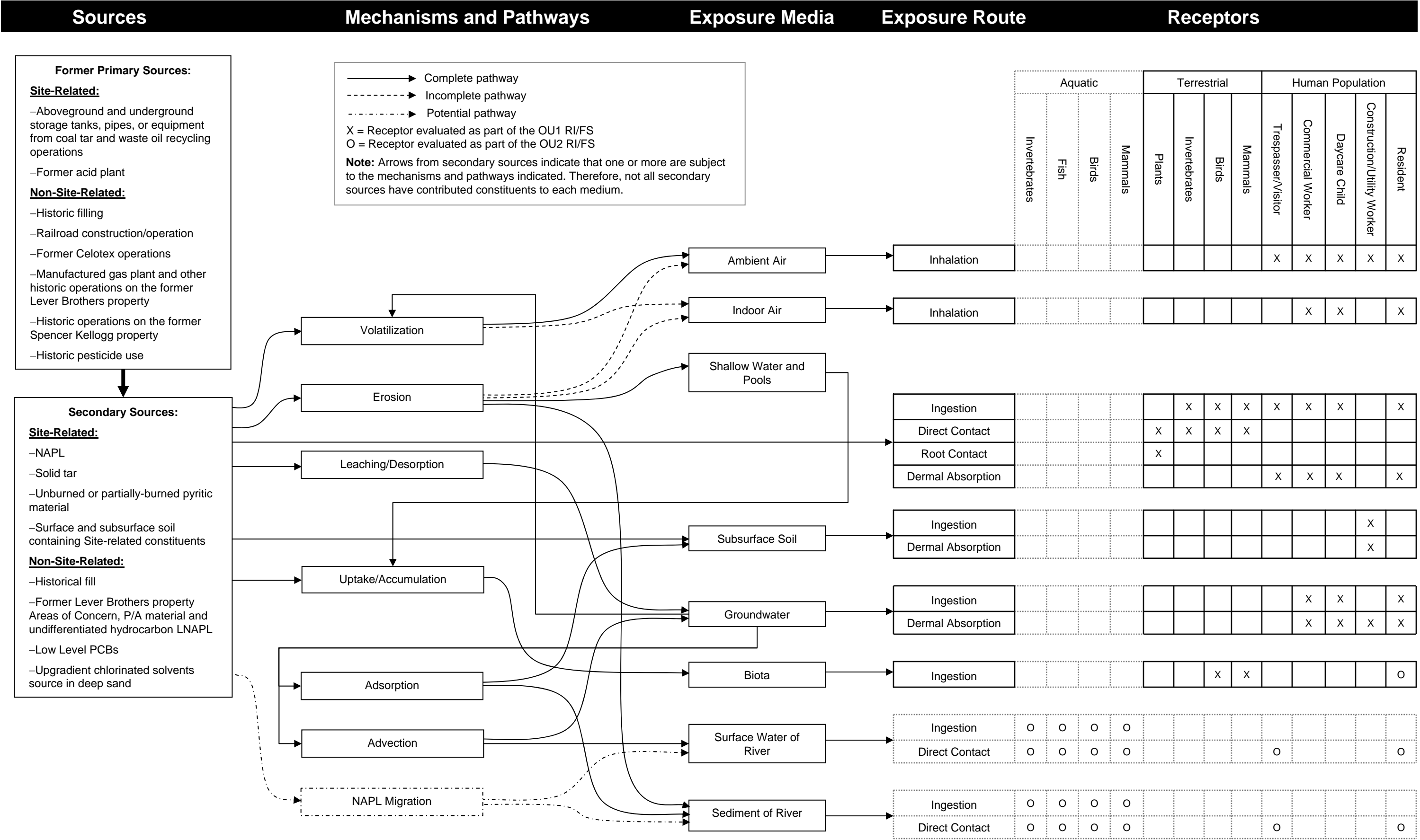
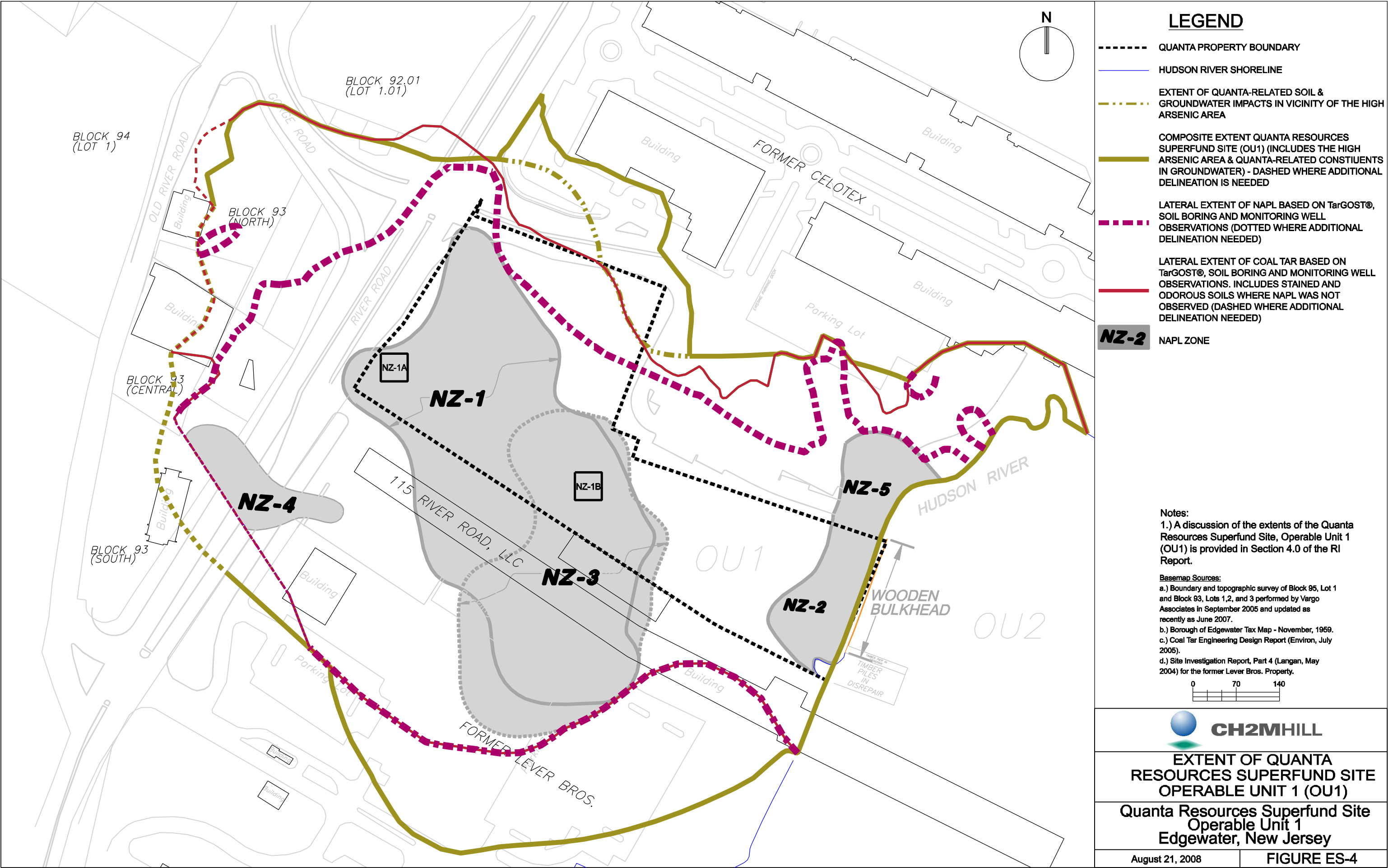
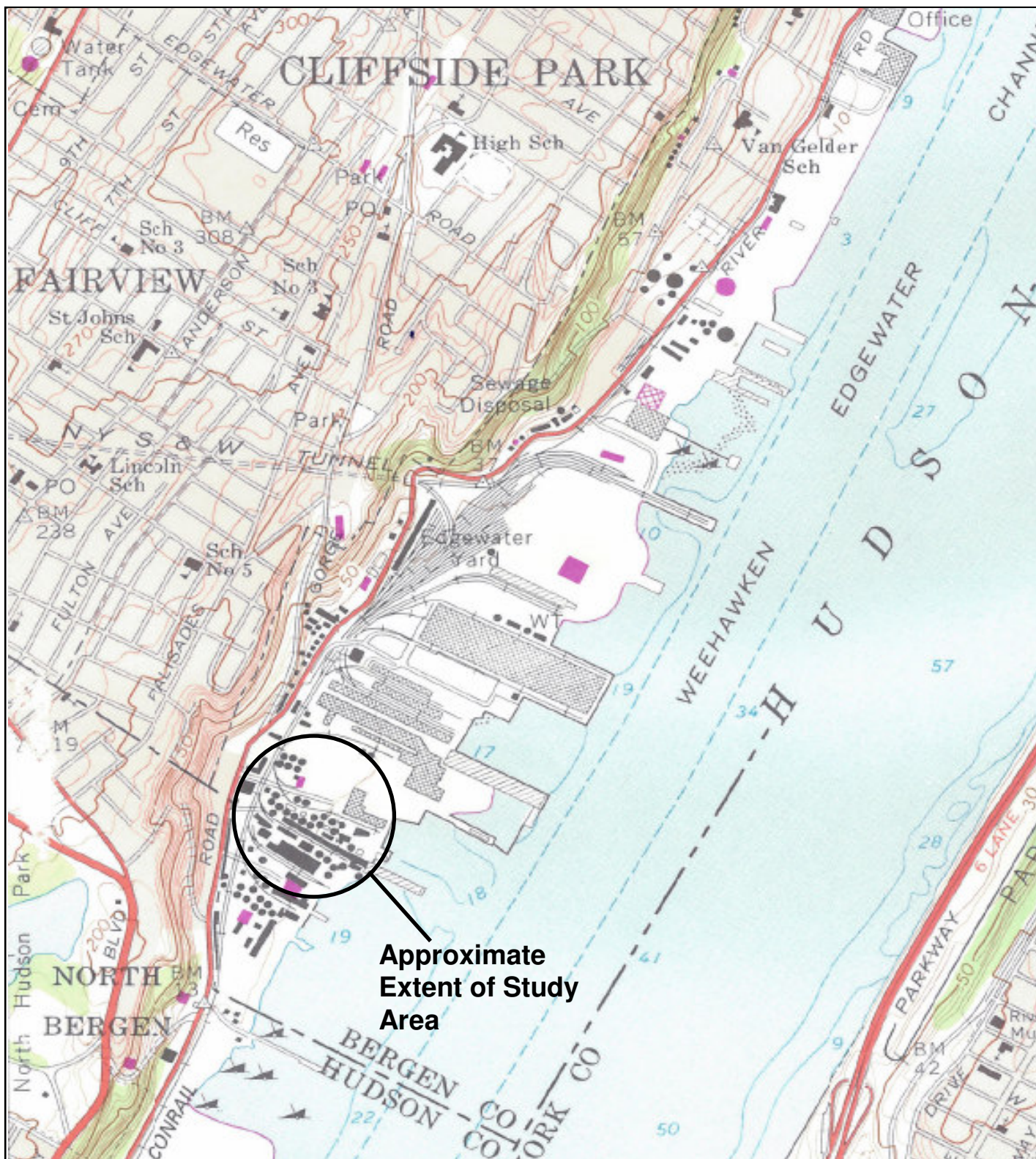


Figure ES-4 is Superseded by Figure ES-5 of the Final SRI Report







Map Source:  
Central Park, New York – New Jersey  
United States Geological Survey  
7.5 Minute Quadrangle

Topography and photogrammetric  
methods from aerial photographs  
taken in 1954 and planetable  
surveys in 1956. Field checked in  
1966. Revised in 1979 from aerial  
photographs taken in 1977.



**CH2MHILL**

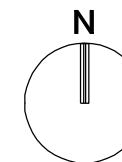
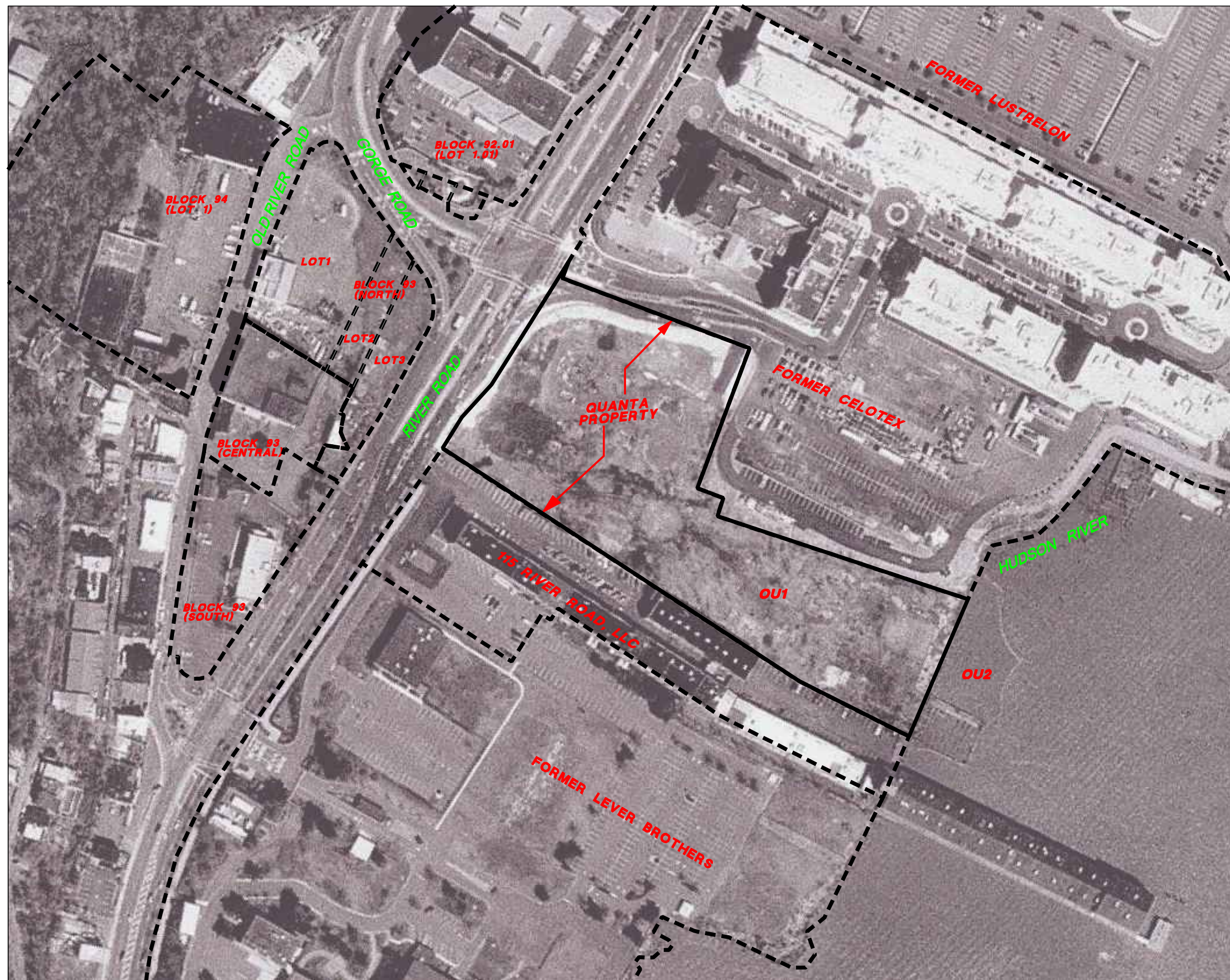
### **Study Area Location Map**

**Quanta Resources Superfund Site  
Operable Unit 1  
Edgewater, New Jersey**

August 14, 2007

**FIGURE 1-1**



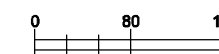


#### LEGEND

--- APPROXIMATE PROPERTY  
BOUNDARIES

#### Notes:

- 1.) Source of Aerial Photograph:  
Aerographics Corporation, 2005. Pic  
No. 20602382S, Frame No. 216. Scale:  
1:3,100, 1 inch - 258 feet. April 16.
- 2.) Approximate property boundaries  
taken from most recent Bergen County  
Tax Maps.
- 3.) For purposes of this figure property  
lines are not extended into the Hudson  
River.



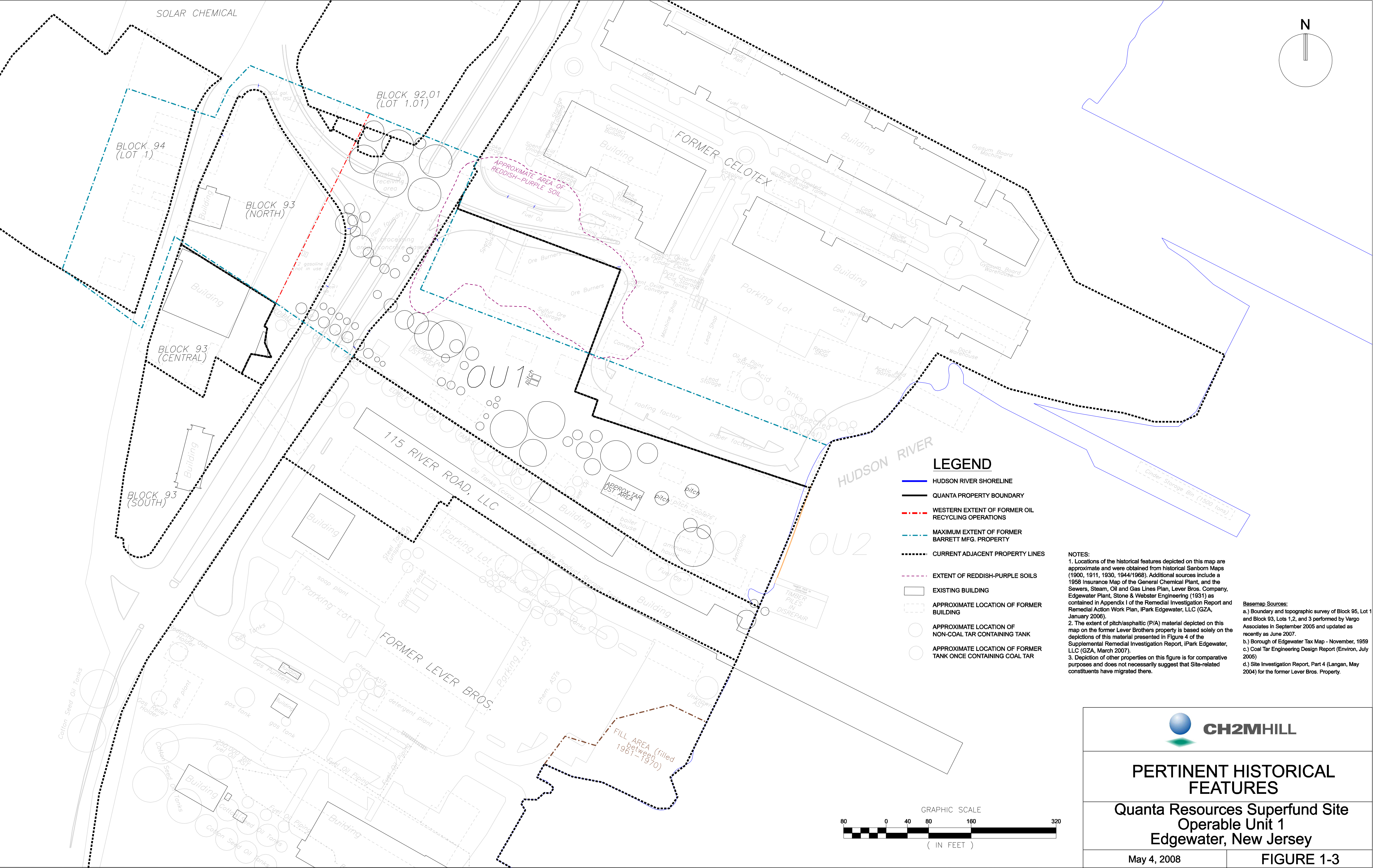
#### PROPERTY LOCATION MAP WITH AERIAL PHOTOGRAPH

Quanta Resources Superfund Site  
Operable Unit 1  
Edgewater, New Jersey

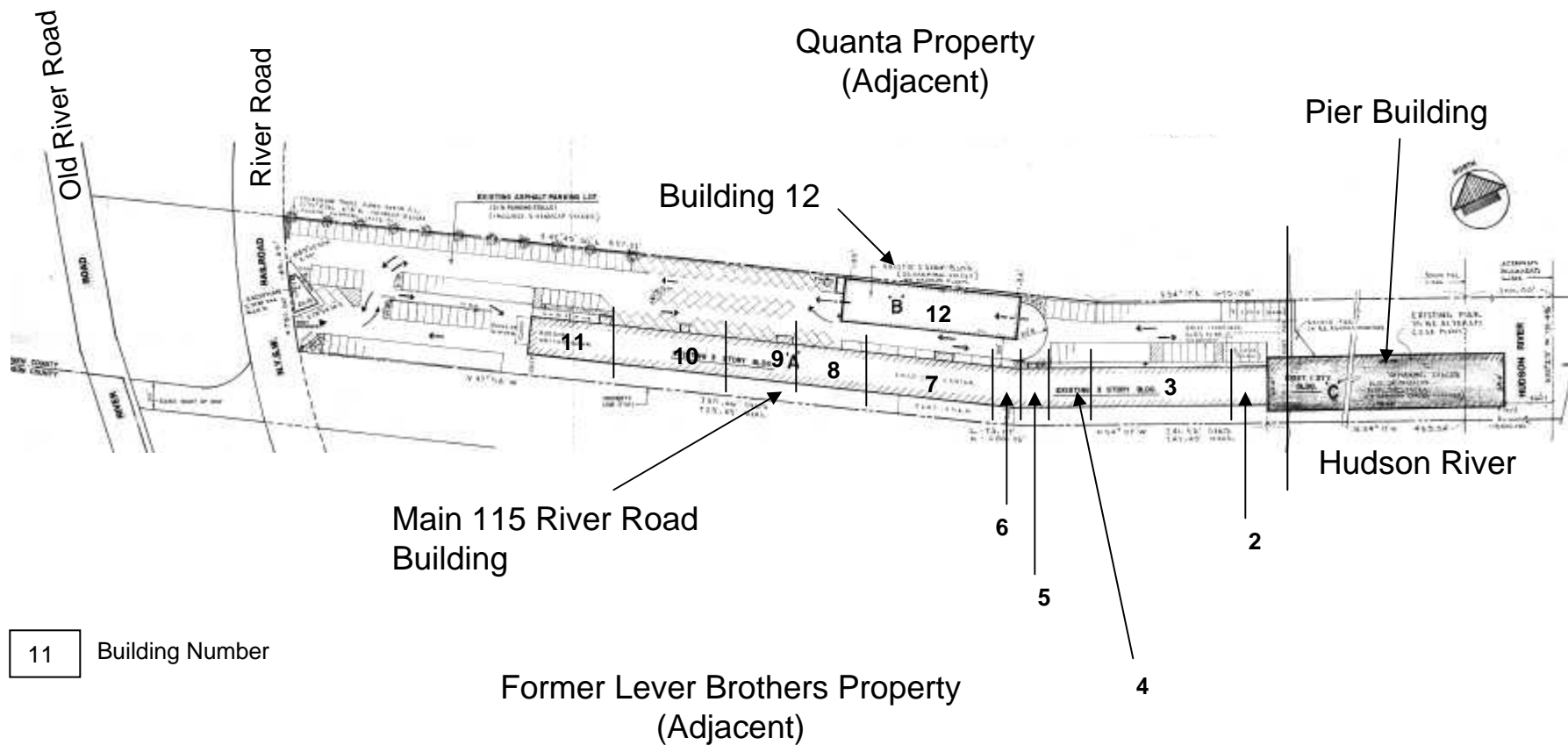
November 1, 2007

FIGURE 1-2










**Notes:**

Figure adapted from April 1994 Site Plan drafted by PMC.

Building interior divisions based a property walk performed in March 2006.

 <b>CH2MHILL</b>	
<b>PLAN VIEW OF 115 RIVER ROAD BUILDINGS</b>	
Quanta Resources Superfund Site Operable Unit 1 Edgewater, New Jersey	
November 5, 2007	<b>FIGURE 1-4</b>



# HISTORIC FILL OF THE CENTRAL PARK QUADRANGLE

2004

## EXPLANATION

The "Brownfield and Contaminated Site Remediation Act" (N.J.S.A. 58:10B-1 et seq.) requires the Department of Environmental Protection to map regions of the state where large areas of historic fill exist and make this information available to the public. This map shows areas of historic fill covering more than approximately 5 acres. For the purposes of this map, historic fill is non-indigenous material placed on a site in order to raise the topographic elevation of the site. No representation is made as to the composition of the fill or presence of contamination in the fill. Some areas mapped as fill may contain chemical-production waste or ore-processing waste that exclude them from the legislative definition of historic fill.

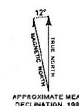
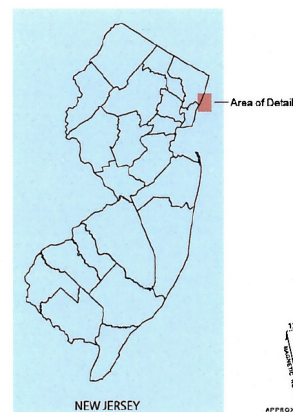
Fill was mapped from stereo aerial photography taken in March 1979, supplemented in places by planimetric aerial photography taken in the spring of 1991 and 1992. Additional areas of fill were mapped by comparing areas of swamp, marsh, and floodplain shown on archival topographic and geologic maps on file at the N. J. Geological Survey, dated between 1840 and 1910, to their modern extent. In a few places, fill was mapped from field observations and from drillers' logs of wells and borings.

Most urban and suburban areas are underlain by a discontinuous layer of excavated indigenous soil mixed with varying amounts of non-indigenous material. This material generally does not meet the definition of historic fill and is not depicted on this map. Also, there may be historic fills that are not detectable on aerial photography or by archival map interpretation and so are not shown on this map, particularly along streams in urban and suburban areas.

**Use of the maps related to the Technical Rules, N.J.A.C. 7:26E**

This map is provided for informational purposes only. The use of this map as the only source of information regarding the presence of historic fill at a site does not fulfill the diligent inquiry requirements of the Preliminary Assessment set forth at N.J.A.C. 7:26E-3.1(c). This map may be used as one source of information to fulfill the requirements of the Site Investigation at N.J.A.C. 7:26E-3.12. **This map is not intended to fulfill the Remedial Investigation requirements associated with historic fill at N.J.A.C. 7:26E-4.6(b).**

Historic Fill  
Non-Fill Area



**Map Source:** NJDEP Land Use Management and New Jersey Geological Survey, Historic Fill of The Central Park Quadrangle, Historic Filling Map (HFM-43)

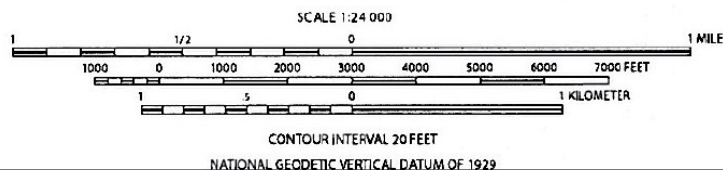
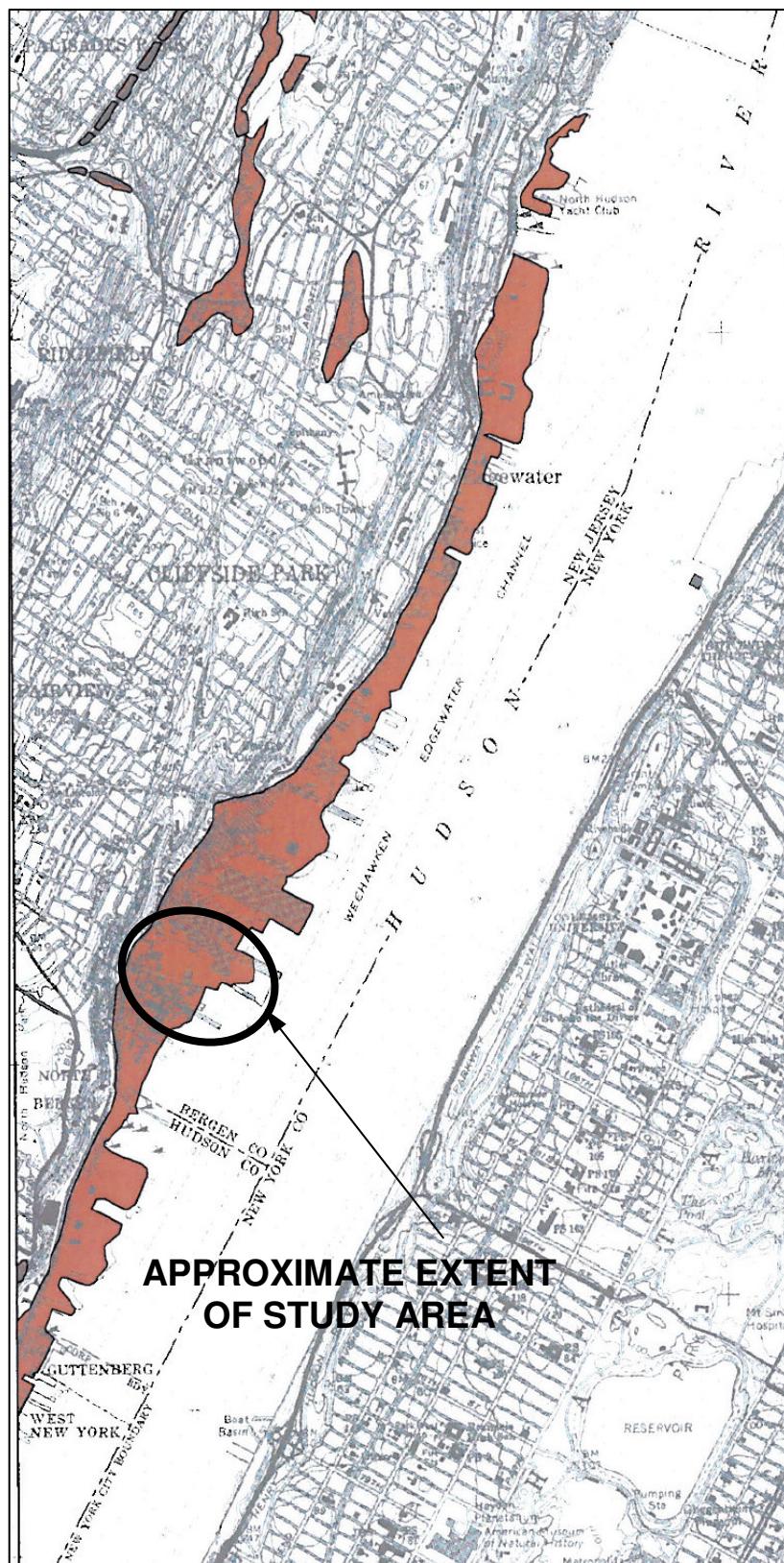


## NJDEP Historic Filling Map

Quanta Resources Superfund Site  
Operable Unit 1  
Edgewater, New Jersey

October 23, 2007

**FIGURE 1-5**



306250



## NOTES TO USERS

This map is for use in administering the National Flood Insurance Program. It does not necessarily identify all areas subject to flooding, particularly from local drainage sources of small size. The **community map repository** should be consulted for possible updated or additional flood hazard information.

To obtain more detailed information in areas where **Base Flood Elevations** (BFEs) and/or **floodways** have been determined, users are encouraged to consult the Flood Profiles, Floodway Data and/or Summary of Stillwater Elevations tables contained within the Flood Insurance Study (FIS) report that accompanies this FIRM. Users should be aware that BFEs shown on the FIRM represent rounded whole-foot elevations. These BFEs are intended for flood insurance rating purposes only and should not be used as the sole source of flood elevation information. Accordingly, flood elevation data presented in the FIS report should be utilized in conjunction with the FIRM for purposes of construction and/or floodplain management.

**Coastal Base Flood Elevations** shown on this map apply only landward of 0.0' National Geodetic Vertical Datum of 1929 (NGVD 29). Users of this FIRM should be aware that coastal flood elevations are also provided in the Summary of Stillwater Elevations tables in the Flood Insurance Study report for this jurisdiction. Elevations shown in the Summary of Stillwater Elevations tables should be used for construction and/or floodplain management purposes when they are higher than the elevations shown on this FIRM.

Boundaries of the **floodways** were computed at cross sections and interpolated between cross sections. The floodways were based on hydraulic considerations with regard to requirements of the National Flood Insurance Program. Floodway widths and other pertinent floodway data are provided in the Flood Insurance Study report for this jurisdiction.

Certain areas not in Special Flood Hazard Areas may be protected by **flood control structures**. Refer to Section 2.4 "Flood Protection Measures" of the Flood Insurance Study report for information on flood control structures in this jurisdiction.

The **projection** used in the preparation of this map was Universal Transverse Mercator (UTM) zone 18. The **horizontal datum** was NAD 83, GRS80 spheroid. Differences in datum, spheroid, projection or UTM zones used in the production of FIRMs for adjacent jurisdictions may result in slight positional differences in map features across jurisdiction boundaries. These differences do not affect the accuracy of this FIRM.

Flood elevations on this map are referenced to the National Geodetic Vertical Datum of 1929. These flood elevations must be compared to structure and ground elevations referenced to the same **vertical datum**. For information regarding conversion between the National Geodetic Vertical Datum of 1929 and the North American Vertical Datum of 1988, visit the National Geodetic Survey website at [www.ngs.noaa.gov](http://www.ngs.noaa.gov) or contact the National Geodetic Survey at the following address:

Spatial Reference System Division  
National Geodetic Survey, NOAA  
Silver Spring Metro Center  
1315 East-West Highway  
Silver Spring, Maryland 20910  
(301) 713-3191

To obtain current elevation, description, and/or location information for **bench marks** shown on this map, please contact the Information Services Branch of the National Geodetic Survey at (301) 713-3242, or visit their website at [www.ngs.noaa.gov](http://www.ngs.noaa.gov).

**Base map** information shown on this FIRM was derived from U.S. Geological Survey Digital Orthophoto Quadrangles (DOQs) produced at a scale of 1:12,000 from photography dated 1995 or later.

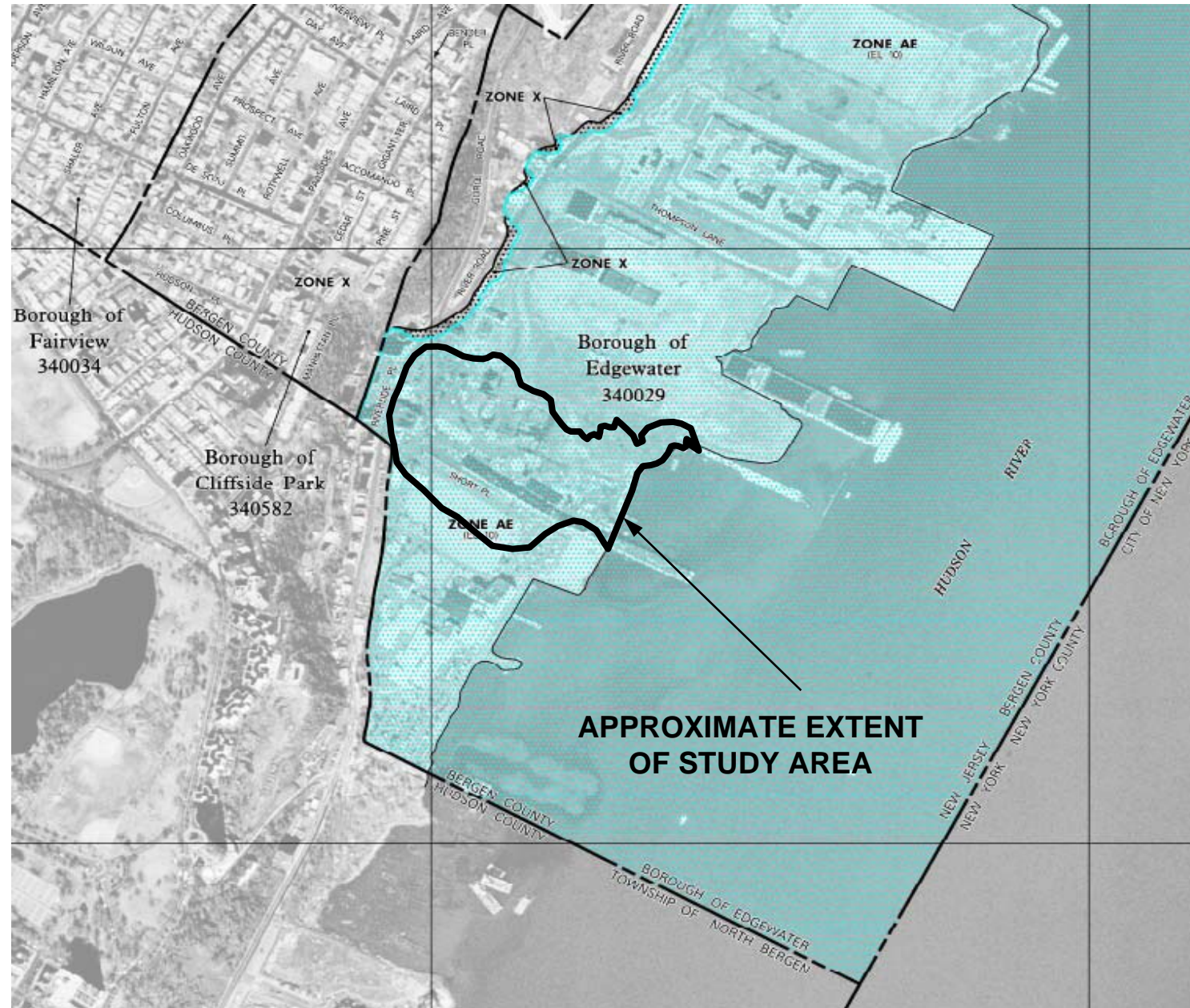
This map reflects more detailed and up-to-date **stream channel configurations** than those shown on the previous FIRM for this jurisdiction. The floodplains and floodways that were transferred from the previous FIRM may have been adjusted to conform to these new stream channel configurations. As a result, the Flood Profiles and Floodway Data tables in the Flood Insurance Study Report (which contains authoritative hydraulic data) may reflect stream channel distances that differ from what is shown on this map.

**Corporate limits** shown on this map are based on the best data available at the time of publication. Because changes due to annexations or de-annexations may have occurred after this map was published, map users should contact appropriate community officials to verify current corporate limit locations.

Please refer to the separately printed **Map Index** for an overview map of the county showing the layout of map panels; community map repository addresses; and a Listing of Communities table containing National Flood Insurance Program dates for each community as well as a listing of the panels on which each community is located.

Contact the **FEMA Map Service Center** at 1-800-358-9616 for information on available products associated with this FIRM. Available products may include previously issued Letters of Map Change, a Flood Insurance Study report, and/or digital versions of this map. The FEMA Map Service Center may also be reached by Fax at 1-800-358-9620 and their website at [www.fema.gov/msc](http://www.fema.gov/msc).

If you have **questions about this map** or questions concerning the National Flood Insurance Program in general, please call 1-877-FEMA MAP (1-877-336-2627) or visit the FEMA website at [www.fema.gov](http://www.fema.gov).



**NFIP** PANEL 0286G

**FIRM**  
FLOOD INSURANCE RATE MAP  
BERGEN COUNTY,  
NEW JERSEY  
(ALL JURISDICTIONS)

PANEL 286 OF 332  
(SEE MAP INDEX FOR FIRM PANEL LAYOUT)

CONTAINS:

COMMUNITY	NUMBER	PANEL	SUFFIX
CLIFFSIDE PARK, BOR. OF	340582	0286	G
EDGEWATER, BOR. OF	340029	0286	G
FAIRVIEW, BOR. OF	340034	0286	G

Map Number  
34003C0286G  
MAP REVISED  
SEPTEMBER 30, 2005  
Federal Emergency Management Agency

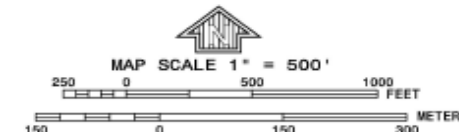
MAP REPOSITORY  
Refer to listing of Map Repositories on Map Index

EFFECTIVE DATE OF COUNTYWIDE  
FLOOD INSURANCE RATE MAP  
SEPTEMBER 20, 1996

EFFECTIVE DATE(S) OF REVISION(S) TO THIS PANEL  
September 30, 2005 - to change Base Flood Elevations and Special Flood Hazard Areas;  
and to reflect updated topographic information.

For community map revision history prior to countywide mapping, refer to the Community Map History table located in the Flood Insurance Study report for this jurisdiction.

To determine if flood insurance is available in this community, contact your insurance agent or call the National Flood Insurance Program at 1-800-638-6620.



## LEGEND

**SPECIAL FLOOD HAZARD AREAS (SFHAs) SUBJECT TO INUNDATION BY THE 1% ANNUAL CHANCE FLOOD**

The 1% annual chance flood (100-year flood), also known as the base flood, is the flood that has a 1% chance of being equaled or exceeded in any given year. The Special Flood Hazard Area is the area subject to flooding by the 1% annual chance flood. Areas of Special Flood Hazard include Zones A, AE, AH, AO, AR, A99, V, and VE. The Base Flood Elevation is the water-surface elevation of the 1% annual chance flood.

- ZONE A** No Base Flood Elevations determined.
- ZONE AE** Base Flood Elevations determined.
- ZONE AH** Flood depths of 1 to 3 feet (usually areas of ponding); Base Flood Elevations determined.
- ZONE AO** Flood depths of 1 to 3 feet (usually sheet flow on sloping terrain); average depths determined. For areas of alluvial fan flooding, velocities also determined.
- ZONE AR** Special Flood Hazard Area formerly protected from the 1% annual chance flood by a flood control system that was subsequently deteriorated. Zone AR indicates that the former flood control system is being restored to provide protection from the 1% annual chance or greater flood.
- ZONE A99** Area to be protected from 1% annual chance flood by a Federal flood protection system under construction; no Base Flood Elevations determined.
- ZONE V** Coastal flood zone with velocity hazard (wave action); no Base Flood Elevations determined.
- ZONE VE** Coastal flood zone with velocity hazard (wave action); Base Flood Elevations determined.

**FLOODWAY AREAS IN ZONE AE**

The floodway is the channel of a stream plus any adjacent floodplain areas that must be kept free of encroachment so that the 1% annual chance flood can be carried without substantial increases in flood heights.

**OTHER FLOOD AREAS**

- ZONE X** Areas of 0.2% annual chance flood; areas of 1% annual chance flood with average depths of less than 1 foot or with drainage areas less than 1 square mile; and areas protected by levees from 1% annual chance flood.

**OTHER AREAS**

- ZONE X** Areas determined to be outside the 0.2% annual chance floodplain.
- ZONE D** Areas in which flood hazards are undetermined, but possible.

**COASTAL BARRIER RESOURCES SYSTEM (CBRS) AREAS**

**OTHERWISE PROTECTED AREAS (OPAs)**

CBRS areas and OPAs are normally located within or adjacent to Special Flood Hazard Areas.

- 1% annual chance floodplain boundary
- 0.2% annual chance floodplain boundary
- Floodway boundary
- Zone D boundary
- CBRS and OPA boundary
- Boundary dividing Special Flood Hazard Areas of different Base Flood Elevations, flood depths or flood velocities.
- Base Flood Elevation line and value; elevation in feet\*
- Base Flood Elevation value where uniform within zone; elevation in feet\*

\*Referenced to the National Geodetic Vertical Datum of 1929

- Cross section line
- Transect line
- Geographic coordinates referenced to the North American Datum of 1927 (NAD 27) Western Hemisphere
- 5000-foot grid ticks; New Jersey State Plane coordinate system, (NAD 27) Transverse Mercator projection
- Bench mark (see explanation in Notes to Users section of this FIRM panel)
- Location of node for stillwater elevation calculation



## FEMA FLOOD PLAIN MAP

Quanta Resources Superfund Site  
Operable Unit 1  
Edgewater, New Jersey

April 23, 2008

FIGURE 2-1

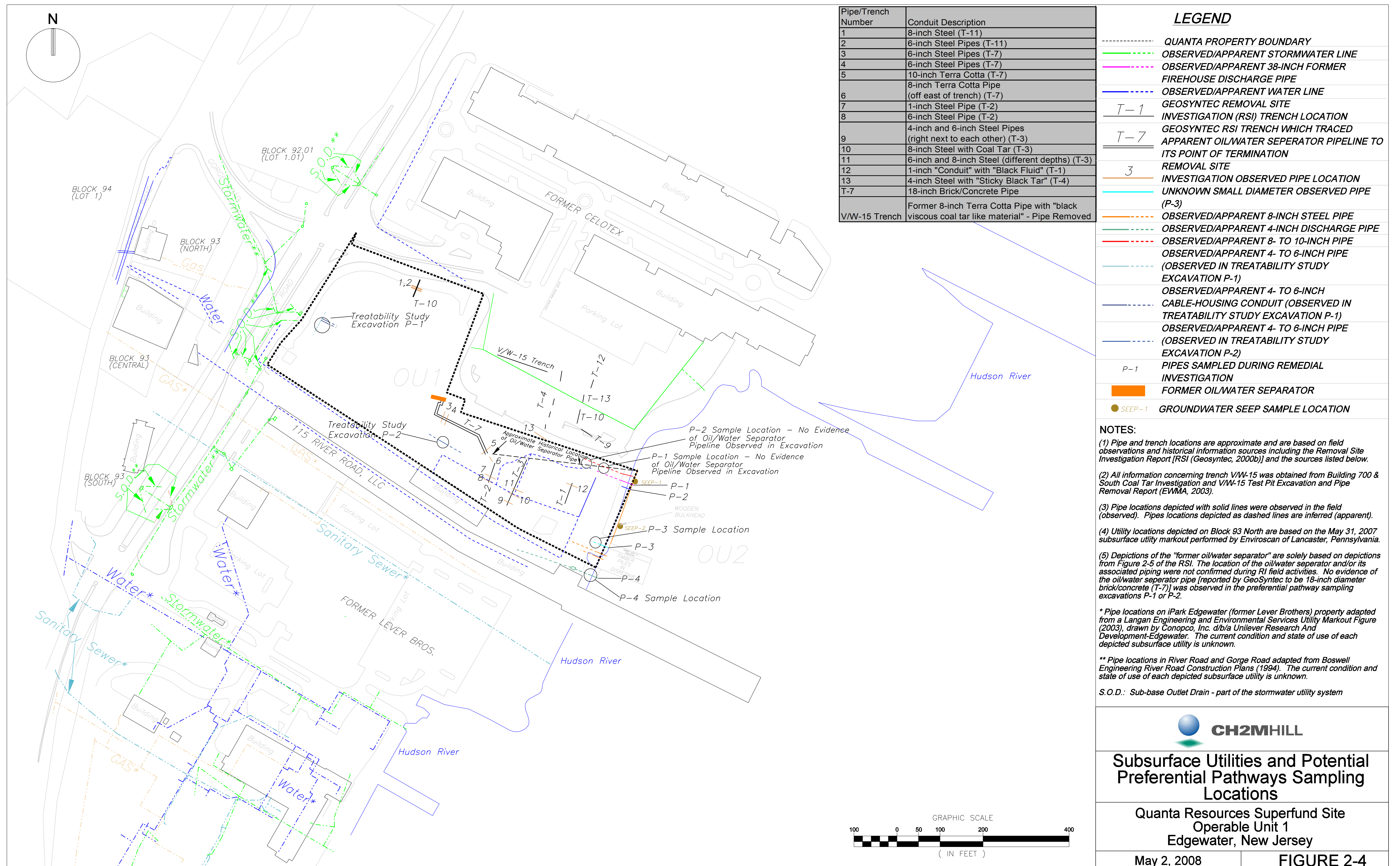




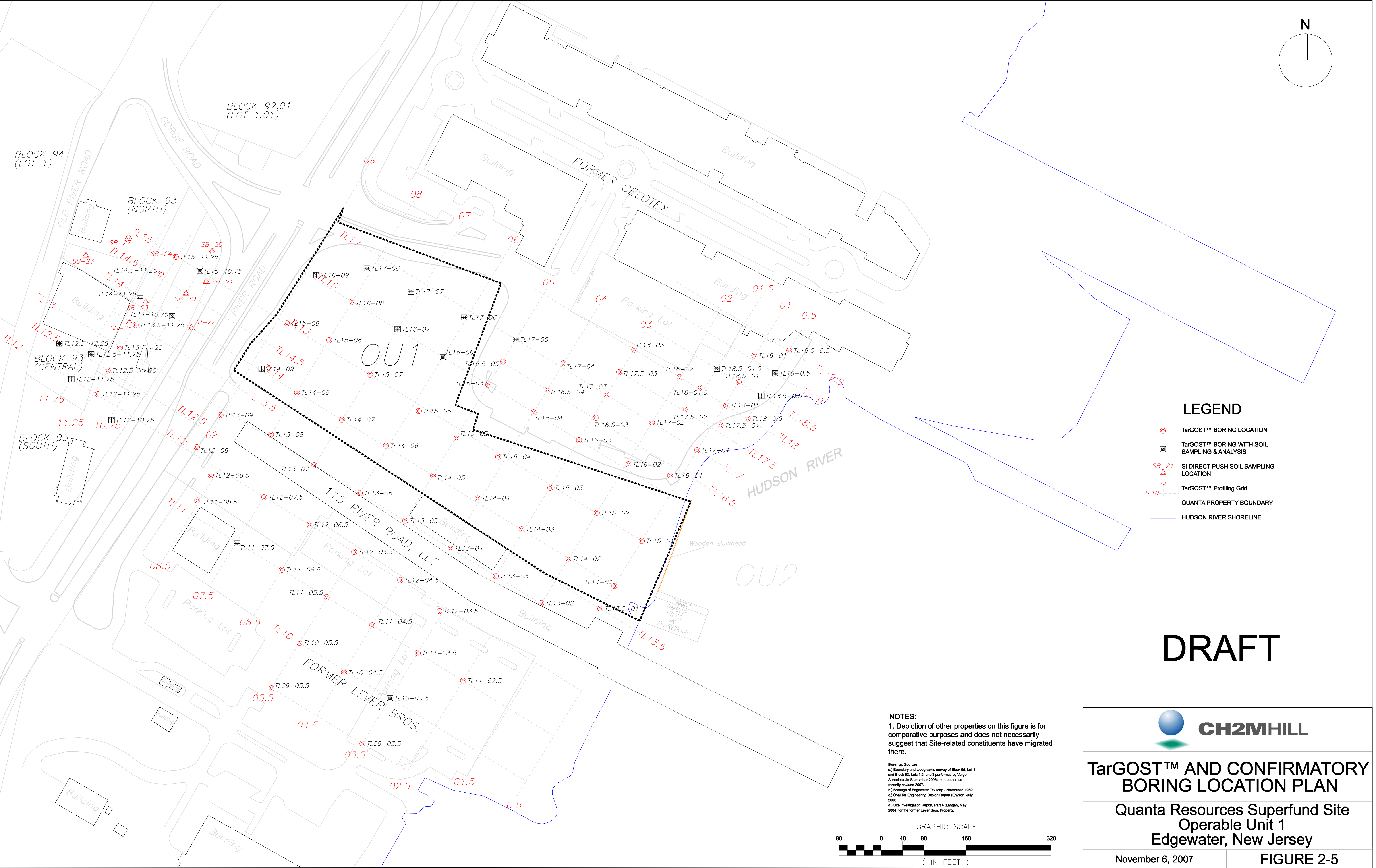




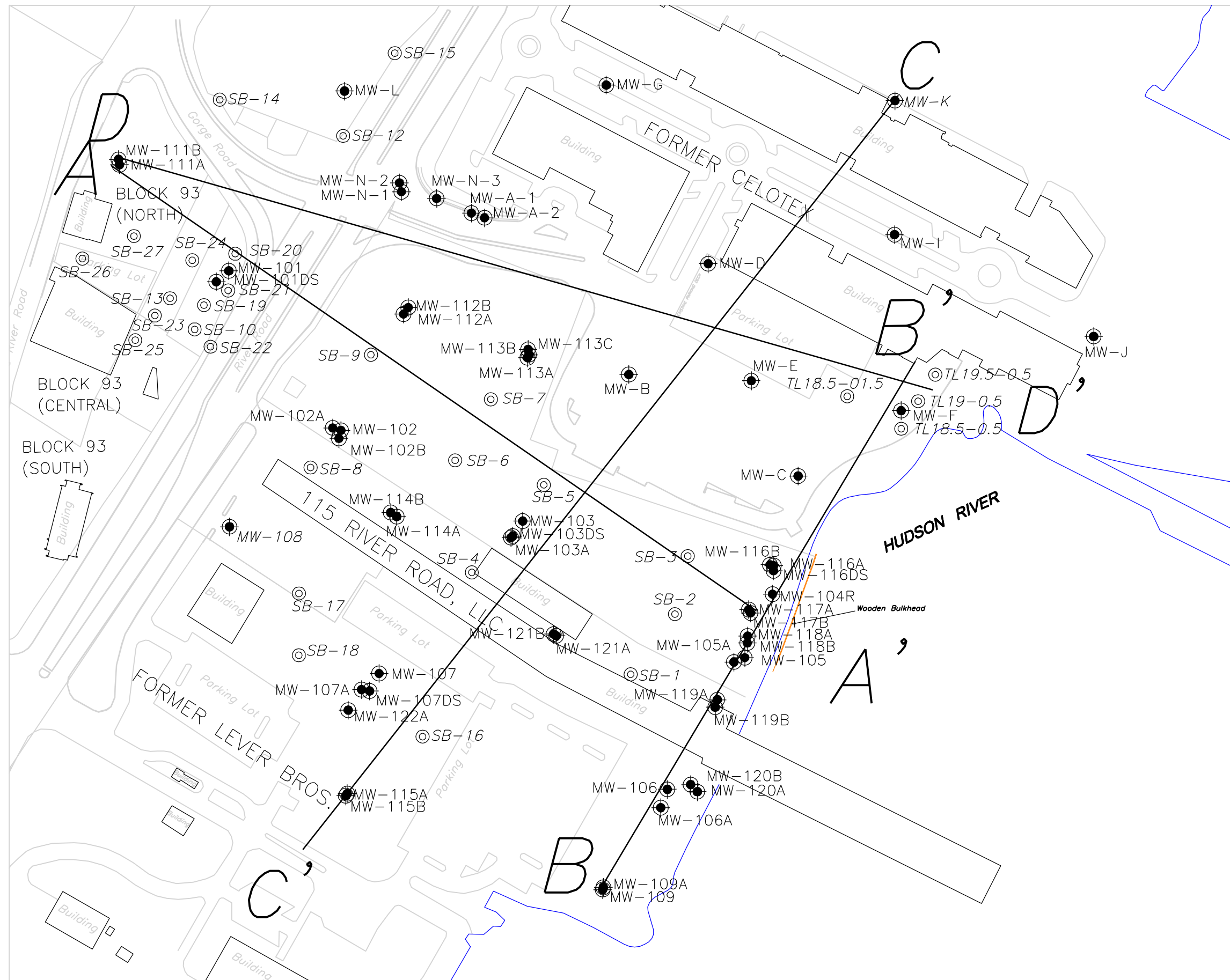








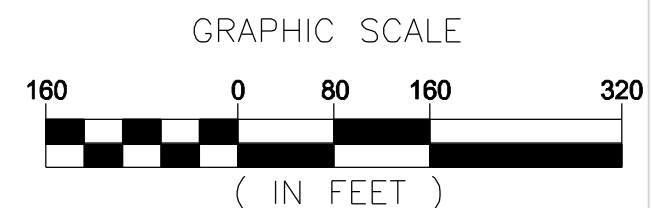




# LEGEND

- EXISTING MONITORING WELL
- SOIL BORING
- QUANTA PROPERTY BOUNDARY
- HUDSON RIVER SHORELINE

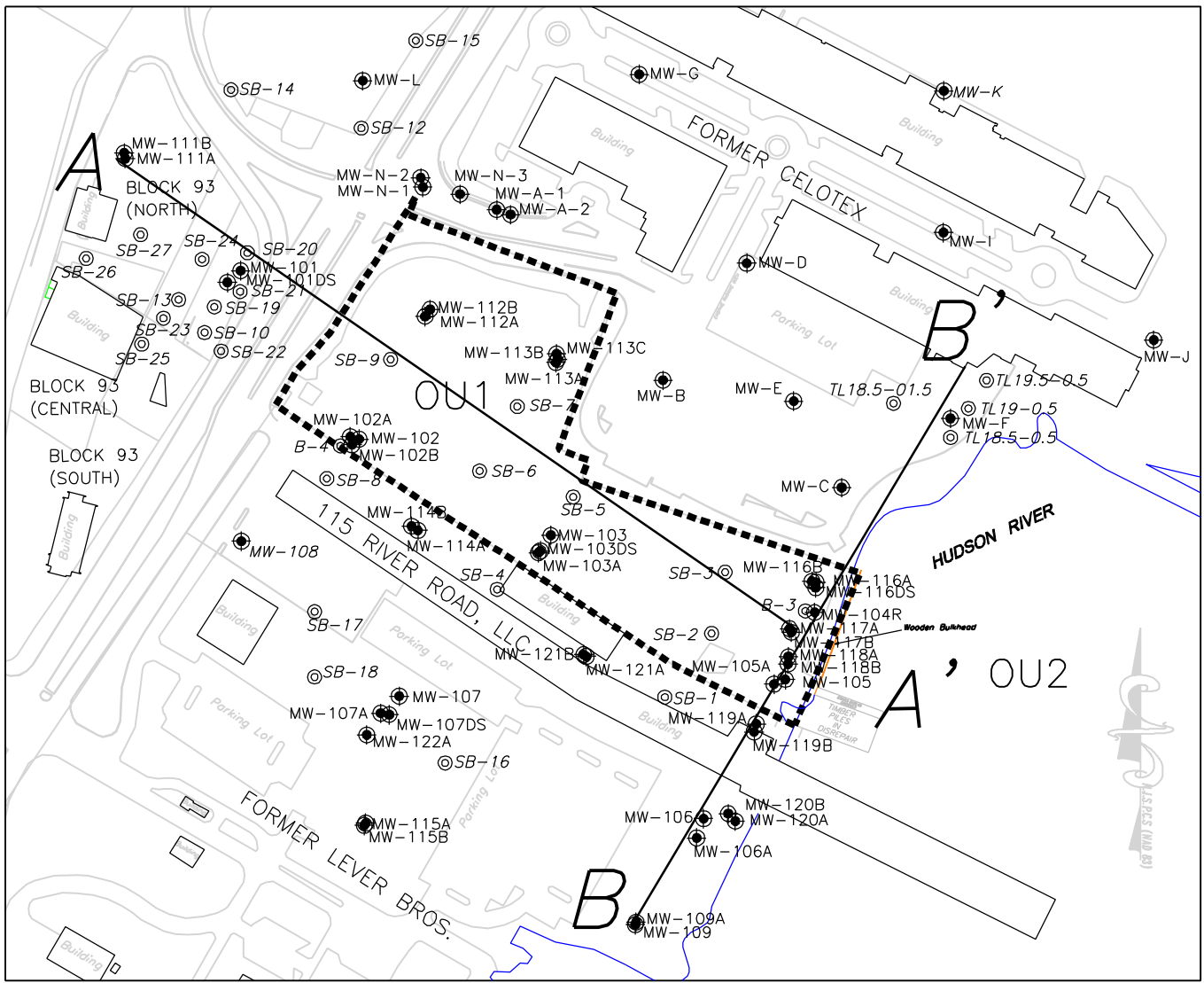
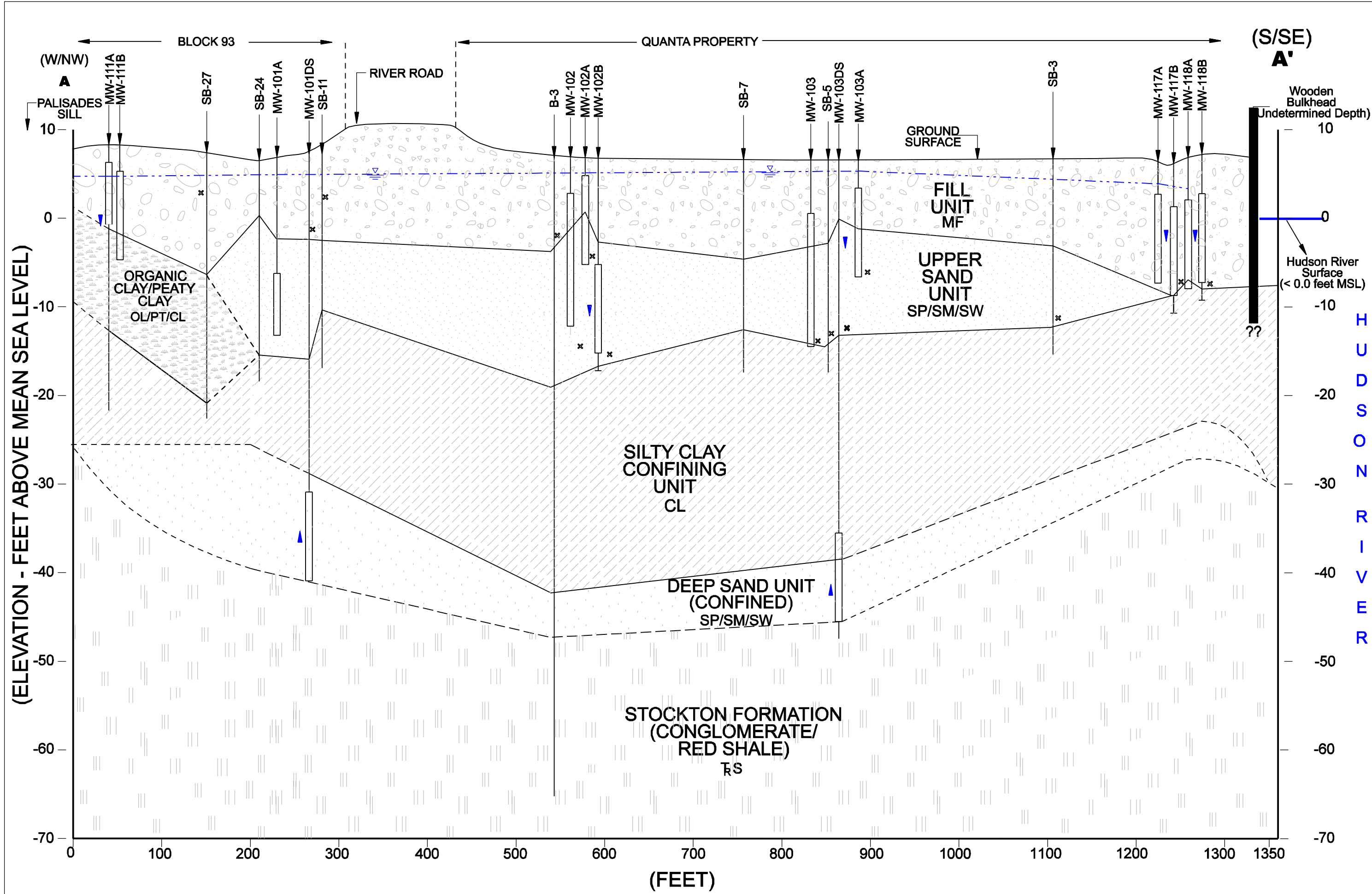
NOTES:  
 1. Depiction of other properties on this figure is for comparative purposes and does not necessarily suggest that Site-related constituents have migrated there.  
 2. Only sampling locations used for geologic cross sections and select other locations are depicted on this figure. All soil and groundwater sample locations are depicted on Figures 2-2 and 2-3, respectively.



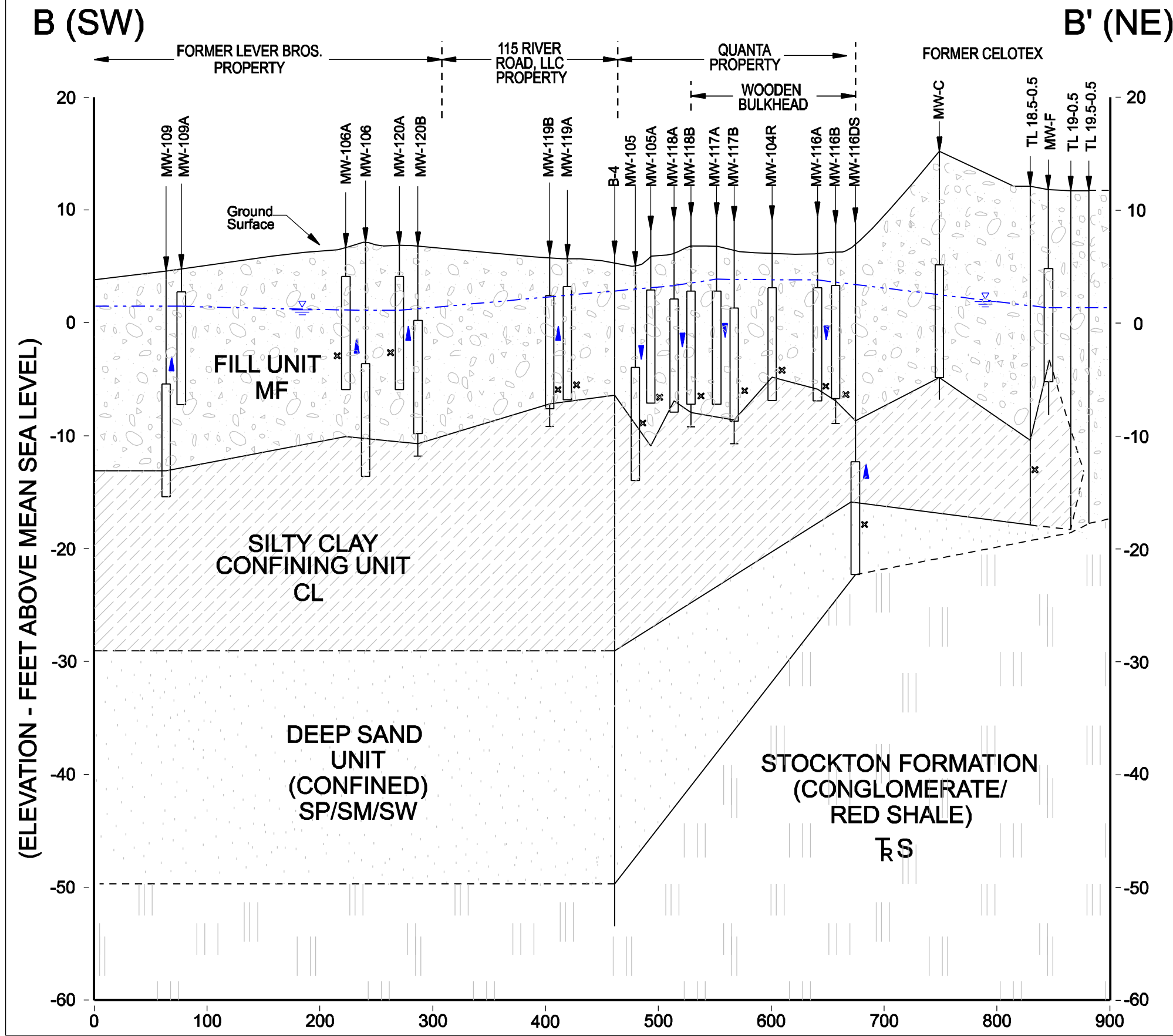
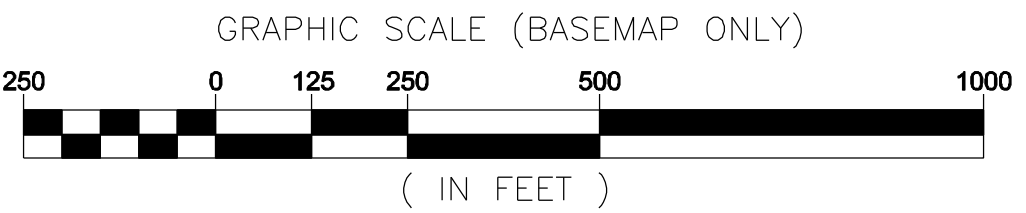
<b>Geologic Cross Section Base Map</b>	
Quanta Resources Site Operable Unit 1 Edgewater, New Jersey	
August 18, 2008	<b>FIGURE 3-1</b>



Figure 3-2 is Superseded by Figures 3-1 and 3-2 of the Final SRI Report



Plan view of the Quanta Resources Superfund Site.



## LEGEND

MONITORING WELL SCREENED INTERVAL  
(MONITORING WELL SUMP)

WATER TABLE (UNCONFINED).  
WATER LEVELS WERE  
COLLECTED MID-TIDE ON  
OCTOBER 16, 2006.

STRATIGRAPHIC CONTACT

STRATIGRAPHIC CONTACT  
(INFERRED)

TS = STOCKTON FORMATION, GREY FELDSPATHIC  
ARKOSE, CONGLOMERATE, AND RED SHALE

SM = SILTY SANDS, SAND-SILT MIXTURE

SP = POORLY-GRADED SANDS, GRAVELLY SANDS,  
LITTLE/NO FINES

SW = WELL - GRADED SANDS, GRAVELLY SANDS,  
LITTLE/NO FINES

CL = INORGANIC CLAYS OF LOW TO MEDIUM  
PLASTICITY, GRAVELLY CLAYS, SANDY CLAYS,  
LEAN CLAYS, SILTY CLAYS

OL/CL/PT = ORGANIC SILTY & CLAYS OF LOW PLASTICITY/PEAT,  
HUMUS, SWAMP SOILS WITH HIGH ORGANIC CONTENT

MF = MIXED FILL (GRAVEL, SAND,  
CINDER/SLAG, BRICK, WOOD)

Direction of vertical hydraulic  
gradient

Denotes wells or soil borings that  
exhibit the presence of NAPL, either  
observed in subsurface soil, or as  
measurable thicknesses in monitoring well.

## NOTES

- DEPICTED BORINGS AND  
MONITORING WELLS ARE LOCATED  
WITHIN 80 FEET OF THE TRANSECT LINE.
- CERTAIN GROUND SURFACE ELEVATIONS  
ARE APPROXIMATE SUCH AS RIVER ROAD.

1" = 10'  
VERTICAL  
1" = 100'  
HORIZONTAL  
(CROSS SECTIONS ONLY)



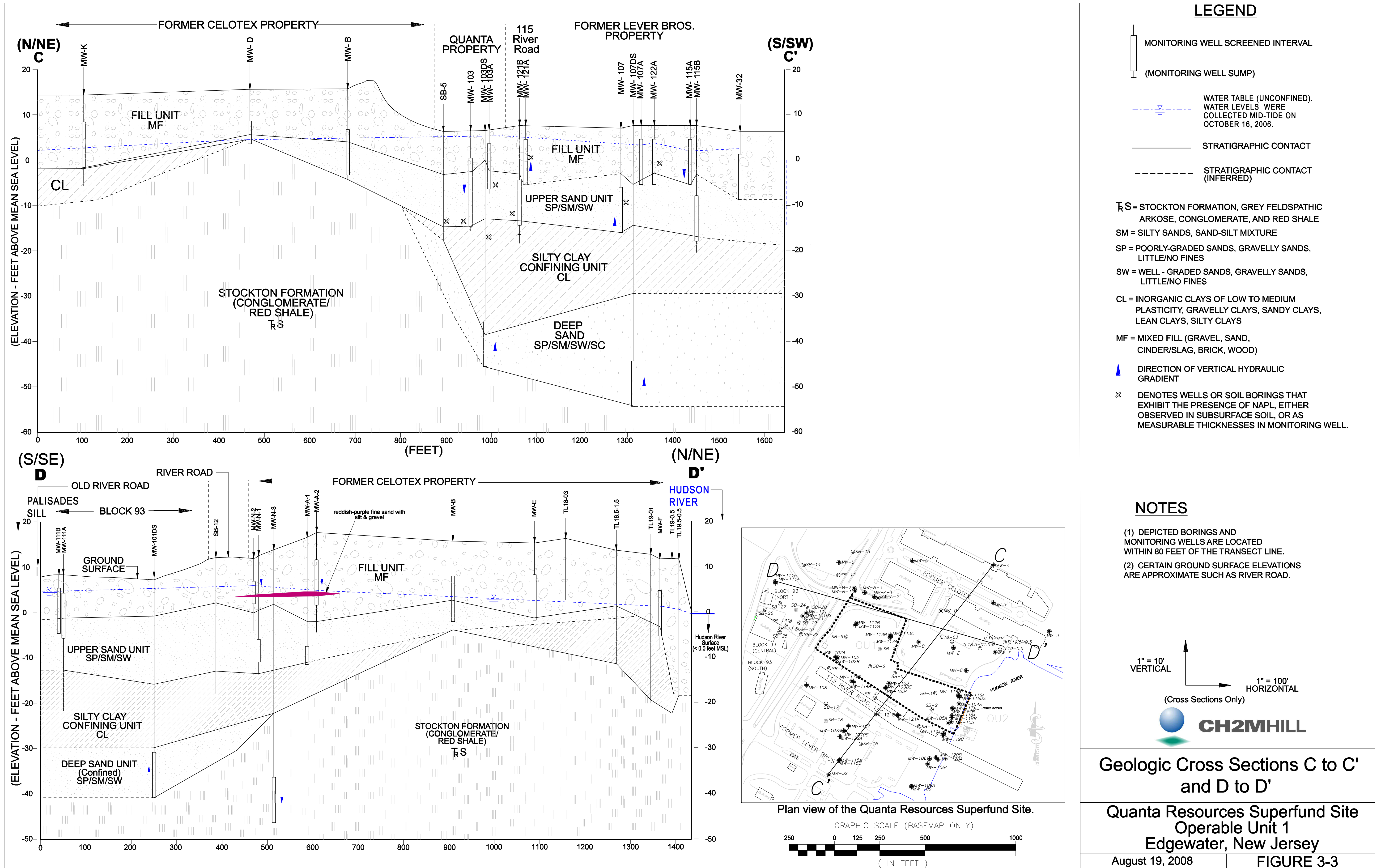
Geologic Cross Sections A to A'  
and B to B'

Quanta Resources Superfund Site  
Operable Unit 1  
Edgewater, New Jersey

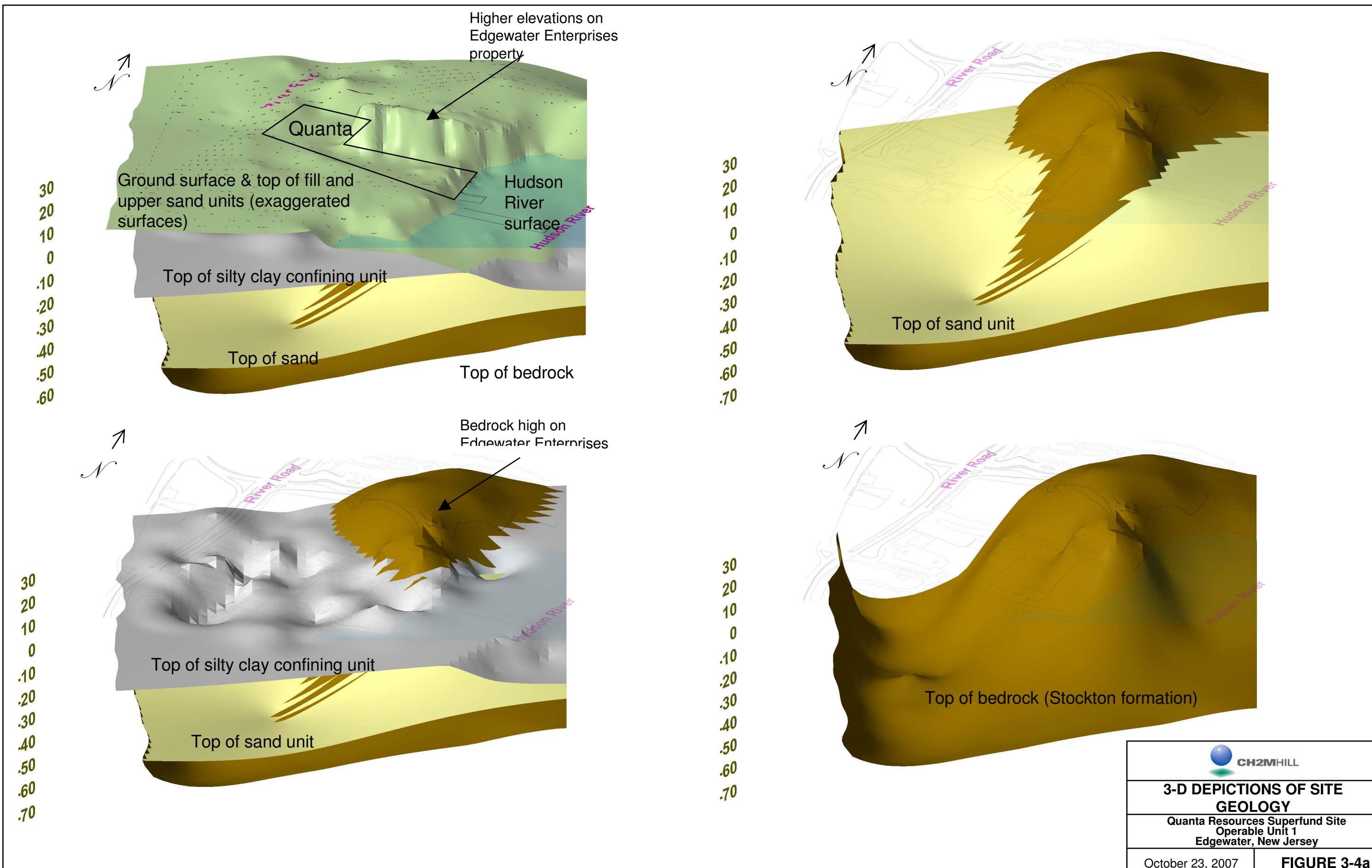
August 18, 2008

FIGURE 3-2

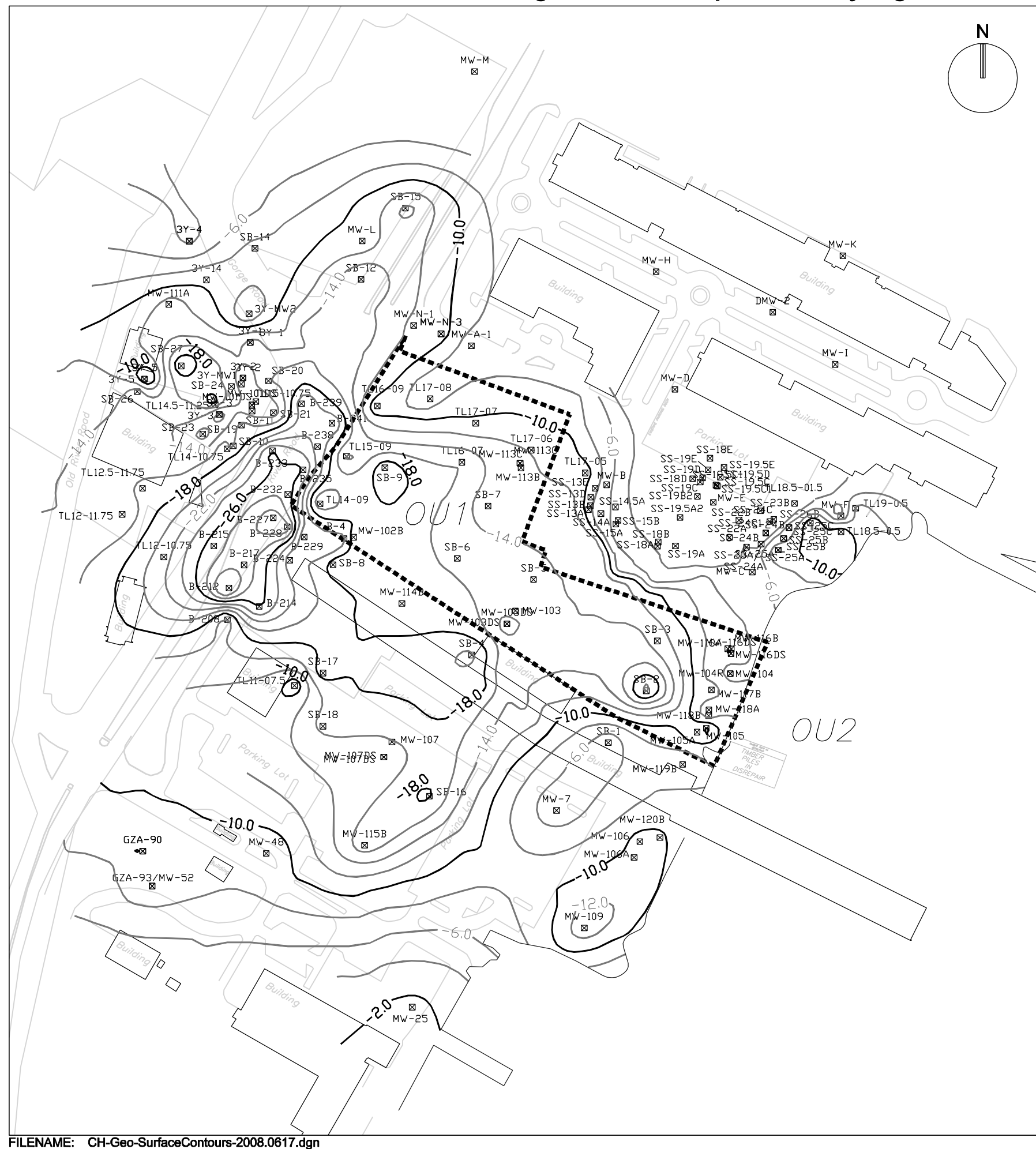








**Figure 3-4b is Superseded by Figure 3-9 of the Final SRI Report**



Well/Boring ID	Easting (NAD83 NJSPC)	Northing (NAD83 NJSPC)	Ground Elevation	Depth to Top of Silty-Clay (ft, bgs)	Elevation of Top of Silty-Clay (ft AMSL) (NAVD83)
3Y-1	632745.0	719118.0	8.5	23	-14.5
3Y-14	632666.0	719231.0	8.5	18	-9.5
3Y-2	632732.0	719054.0	7.5	20.5	-13
3Y-3	632689.0	718988.0	6.2	17.5	-11.3
3Y-4	632635.0	719301.0	10.6	14.5	-3.9
3Y-5	632554.0	719052.0	6.5	15	-8
3Y-MW1	632729.0	719043.0	7.3	20.5	-13.2
3Y-MW2	632743.0	719170.0	12.5	19	-6.5
B-208	632704.1	718617.1	9	25	-16
B-212	632706.5	718674.4	9	41	-32
B-214	632761.4	718641.3	9	35	-26
B-215	632679.1	718750.7	9	36	-27
B-224	632816.4	718724.4	9	30	-21
B-227	632786.5	718801.3	9	40	-31
B-228	632812.2	718785.1	9	40	-31
B-229	632842.5	718766.5	9	30	-21
B-232	632812.9	718843.6	9	35	-26
B-233	632785.2	718922.1	9	35	-26
B-235	632840.2	718887.9	9	35	-26
B-238	632866.6	718930.0	9	30	-21
B-239	632837.5	719007.1	9	30	-21
B-241	632892.8	718972.1	9	30	-21
B-4	632914.6	718763.6	6.62	27	-20.38
GZA-90	632560.9	718199.0	7	15	-8
GZA-93/MW-52	632567.8	718135.9	7	16.5	-9.5
MW-101DS	632748.1	719005.0	7.1	23	-15.9
MW-102B	632931.5	718766.3	6.8	23.5	-16.7
MW-103	633224.0	718633.1	6.4	21	-14.6
MW-103DS	633208.6	718610.0	6.5	19.7	-13.2
MW-104	633611.9	718519.8	6.2	12.5	-6.3
MW-104R	633611.9	718519.8	6.2	11	-4.8
MW-105	633568.9	718420.5	5.5	18	-12.5
MW-105A	633562.2	718414.2	5.9	16.8	-10.9
MW-106	633448.6	718216.3	7.4	18	-10.6
MW-106A	633438.5	718187.9	7.1	17.25	-10.15
MW-107	633001.0	718396.3	7	23	-16
MW-107DS	632986.2	718369.2	7.6	22	-14.4
MW-109	633348.4	718060.5	4.8	18	-13.2
MW-111A	632597.9	719186.9	8.4	21	-12.6
MW-113B	633233.9	718891.6	7	19	-12
MW-113C	633232.4	718899.8	7.2	20.25	-13.05
MW-114B	633019.0	718646.5	7.6	24.2	-16.6
MW-115B	632951.6	718209.6	7.6	24.5	-16.9
MW-116A	633607.7	718564.9	6.1	12	-5.9
MW-116B	633614.0	718564.0	6.3	13.2	-6.9
MW-116DS	633613.7	718556.0	6.1	13.2	-7.1
MW-117B	633577.9	718490.4	6.3	15	-8.9
MW-118A	633573.5	718454.5	6.1	13	-6.7
MW-118B	633573.0	718443.7	6.8	14.75	-7.95
MW-119B	633526.3	718355.5	6.4	13	-6.6
MW-120B	633485.0	718223.2	7.2	17.5	-10.3
MW-25	633037.6	717917.3	7.4	9	-1.6
MW-48	632774.0	718195.0	6.74	15	-8.26
MW-52	632567.8	718135.9	7	16.916	-9.916
MW-7	633298.5	718272.8	7.3	12	-4.7
MW-A-1	633144.4	719111.8	11.94	25	-7.08

Well/Boring ID	Easting (NAD83 NJSPC)	Northing (NAD83 NJSPC)	Ground Elevation	Depth to Top of Silty-Clay (ft. bgs)	Elevation of Top of Silty-Clay (ft AMSL) (NAVD83)
MW-C	633651.9	718703.2	17	21	-4
MW-F	633811.9	718804.9	13.16	16.5	-3.34
MW-J	633801.5	719078.3	16.5	19	-2.5
MW-K	633815.3	719274.5	15.61	16	-0.39
MW-L	632947.3	719301.4	16.79	27.5	-10.71
MW-N-1	633040.3	719148.7	13.9	25.5	-11.1
MW-N-3	633089.8	719133.7	15.19	26	-10.81
SB-1	633391.7	718395.1	7.4	12.5	-5.1
SB-10	632714.6	718931.2	5.4	21	-15.6
SB-11	632748.3	718994.0	7.2	17.6	-10.4
SB-12	632945.2	719231.9	11.5	27.5	-16
SB-14	632753.5	719288.1	12.5	21	-8.5
SB-15	633025.4	719360.5	12.2	26.5	-14.3
SB-16	633068.5	718298.4	7.4	25.5	-18.1
SB-17	632876.5	718520.8	6.6	25	-18.4
SB-18	632876.3	718424.8	7.5	23.75	-16.25
SB-19	632729.2	718968.7	6.5	23	-16.5
SB-2	633460.5	718488.8	7.2	27.5	-20.3
SB-20	632778.1	719048.7	9	25	-16.6
SB-21	632787.0	718991.2	11.3	24.5	-13.2
SB-23	632659.3	718952.7	5.5	17	-11.5
SB-24	632710.9	719038.5	6.5	22	-15.5
SB-26	632541.0	719029.4	5.8	20.5	-14.7
SB-27	632620.5	719075.5	7.7	27	-19.3
SB-3	633480.4	718578.9	6	19	-13
SB-4	633145.0	718553.5	8.4	28.8	-20.4
SB-5	633256.9	718689.6	6.3	21.1	-14.8
SB-6	633119.1	718727.7	6.1	21.7	-15.6
SB-7	633174.6	718822.5	6.6	19.25	-12.65
SB-8	632894.5	718716.5	6.8	24	-17.2
SB-9	632988.4	718891.7	6.3	25.5	-19.2
SS-19.5C1	633588.9	718858.8	16.25	15.5	0.75
SS-24B	633676.3	718774.0	15.61	19	-3.39
SS-24C	633690.7	718798.4	15.57	18	-2.43
SS-24C1	633683.5	718794.6	15.62	22.5	-6.88
SS-25A	633698.7	718743.1	14.93	25	-10.07
SS-25B	633708.5	718764.0	14.66	21	-6.34
SS-25C	633717.9	718783.4	14.83	22	-7.17
SS-26B	633756.6	718791.9	13.94	26	-12.06
TL11-07.5	632824.9	718498.2	8.6	20	-11.4
TL12.5-11.75	632550.7	718854.4	5.5	22	-16.5
TL12-10.75	632588.8	718730.3	6.7	28	-21.3
TL12-11.75	632513.5	718807.6	5.9	20	-14.1
TL14.5-11.25	632681.6	719005.9	6.4	25	-18.6
TL14-09	632871.2	718826.7	7.3	22	-14.7
TL14-10.75	632703.1	718926.1	5.2	22.5	-17.3
TL15-09	632918.9	718912.6	9.7	23.5	-13.8
TL15-10.75	632755.3	719011.4	7.7	20	-12.3
TL16-07	633127.3	718901.6	6.8	22.5	-15.7
TL16-09	632974.5	719003.3	11.8	21	-9.2
TL17-05	633349.9	718882.3	15.2	26	-10.8
TL17-07	633152.4	718972.2	6.9	17.5	-10.6
TL17-08	633070.0	719016.2	7.2	15	-7.8
TL18.5-0.5	633812.2	718775.8	12.1	22.5	-10.4
TL18.5-01.5	633728.1	718827.1	13.7	15	-1.3
TL19-0.5	633838.4	718818.6	11.7	20	-8.3

## NOTES

1. Ground surface elevations obtained from field survey data performed on behalf of CH2M HILL by Vargo Associates and lithology elevations were obtained from CH2M HILL boring logs for CH2M HILL sample locations. Ground surface and lithology elevations for Non-CH2M HILL locations obtained from boring logs from other consultants including GeoSyntec, EWMA, PMK Group, and GZA.



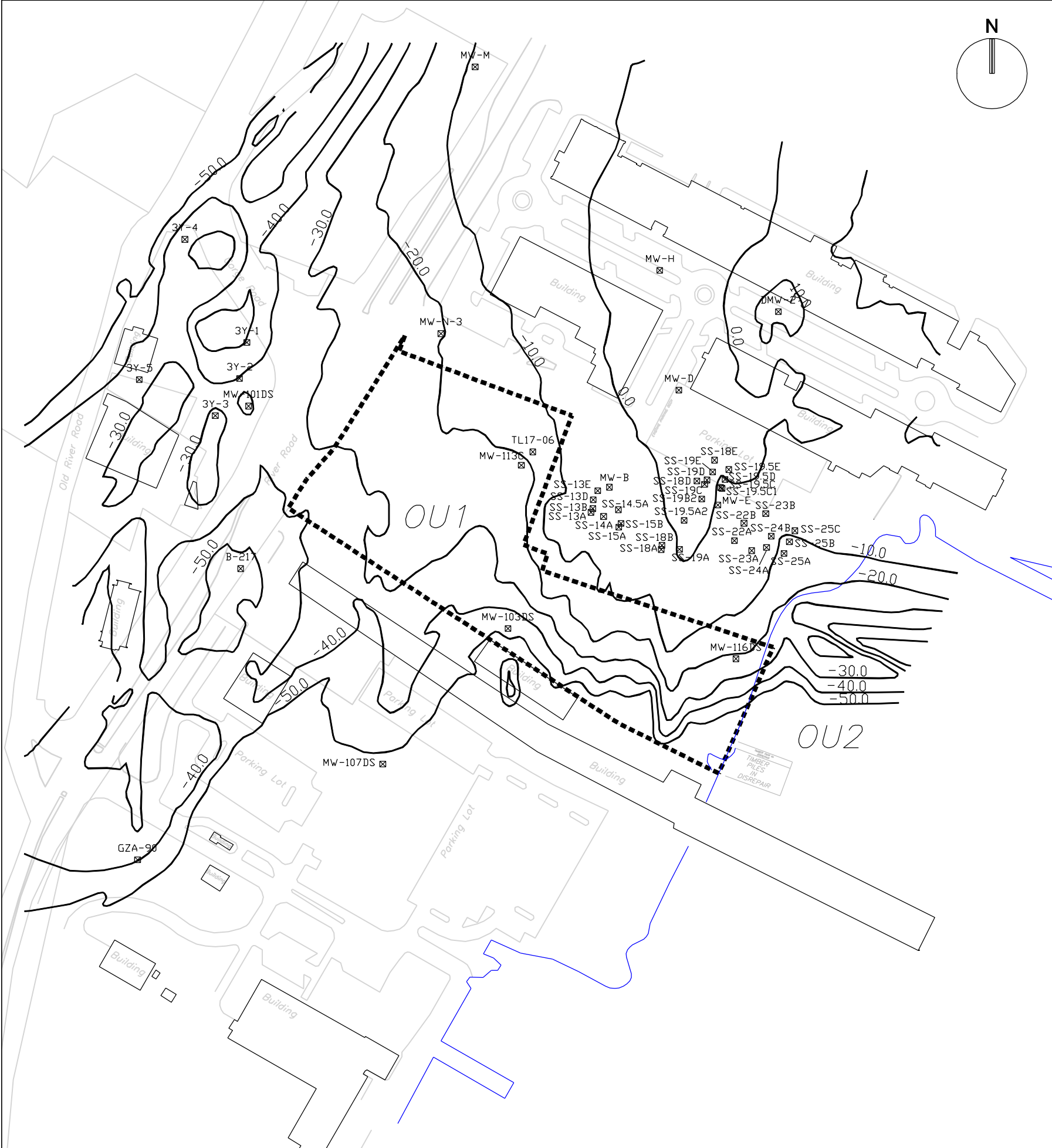
## TOP OF SILTY-CLAY ELEVATION CONTOUR MAP

Quanta Resources Superfund Site  
Operable Unit 1  
Edgewater, New Jersey

**June 26, 2008**

**FIGURE 3-4b**





FILENAME: CH-Geo-SurfaceContours-2008.0617.dgn

-----

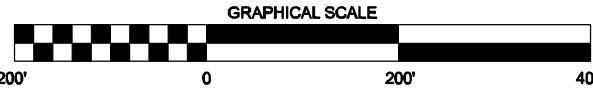
QUANTA PROPERTY  
BOUNDARY

⊠

TOP OF BEDROCK  
ELEVATION DATA POINT

-10.0 ———

ELEVATION CONTOUR  
TOP OF BEDROCK (ft amsl)



Well/Boring ID	Easting (NAD83 NJSPC)	Northing (NAD83 NJSPC)	Ground Elevation	Depth to Top of Bedrock (ft. bgs)	Elevation of Top of Bedrock (ft AMSL) (NAVD88)
3Y-1	632745.0	719118.0	8.5	57	-48.5
3Y-2	632732.0	719054.0	7.5	48	-40.5
3Y-3	632689.0	718988.0	6.2	34.5	-28.3
3Y-4	632635.0	719301.0	10.6	45	-34.4
3Y-5	632554.0	719052.0	6.5	39	-32.5
B-217	632734.1	718716.2	9.0	64	-55
DMW-2	633688.6	719172.5	15.0	31	-16
GZA-90	632550.9	718199.0	7.0	46.5	-39.5
MW-101DS	632748.1	719005.0	7.1	48	-40.9
MW-103DS	633208.6	718610.0	6.5	53	-46.5
MW-107DS	632986.2	718369.2	7.6	62	-54.4
MW-113C	633232.4	718899.8	7.2	30	-22.8
MW-116DS	633613.7	718556.0	6.1	29	-22.9
MW-B	633388.9	718861.0	17.0	20	-3
MW-D	633512.2	719033.1	16.9	11	5.9
MW-E	633581.4	718829.2	16.7	17	-0.27
MW-H	633478.3	719246.0	15.3	9	6.3
MW-M	633150.5	719607.4	17.2	26	-8.81
MW-N-3	633089.8	719133.7	15.2	36	-20.81
SS-13A	633356.0	718816.2	17.0	20	-3
SS-13B	633359.4	718822.8	17.0	18	-1
SS-13D	633360.1	718838.4	17.2	26	-8.82
SS-13E	633368.2	718854.6	16.8	22.5	-5.72
SS-14.5A	633404.6	718820.9	17.0	24	-7.03
SS-14A	633378.5	718808.7	17.1	24	-6.91
SS-15A	633405.3	718790.0	17.1	24	-6.86
SS-15B	633409.4	718796.3	17.1	25	-7.95
SS-18A	633480.8	718750.2	17.7	23	-5.34
SS-18B	633482.2	718757.6	17.5	22.5	-4.98
SS-18D	633544.3	718871.7	16.9	10	6.92
SS-18E	633575.3	718908.8	15.9	13	2.9
SS-19.5A2	633521.6	718801.8	16.9	14	2.9
SS-19.5C	633586.1	718860.1	16.3	17.5	-1.25
SS-19.5C1	633588.9	718858.8	16.3	17	-0.75
SS-19.5D	633594.1	718874.7	16.1	17	-0.92
SS-19.5E	633600.9	718892.2	16.2	11	5.17
SS-19A	633513.0	718750.6	17.4	17	0.35
SS-19B2	633553.0	718840.0	16.7	13	3.7
SS-19C	633557.9	718865.7	16.8	14.5	2.28
SS-19D	633562.2	718873.5	16.6	14.5	2.09
SS-19E	633572.1	718888.0	16.3	13	3.31
SS-22A	633610.9	718765.8	16.7	19	-2.26
SS-22B	633627.7	718796.9	16.7	20	-3.32
SS-23A	633641.3	718748.1	16.3	21	-4.68
SS-23B	633666.4	718813.9	16.1	22.5	-6.39
SS-24A	633667.9	718754.0	15.9	17.5	-1.62
SS-24B	633676.3	718774.0	15.6	24	-8.39
SS-25A	633698.7	718743.1	14.9	29	-14.07
SS-25B	633708.5	718764.0	14.7	28.2	-13.54
SS-25C	633717.9	718783.4	14.8	23	-8.17
TL17-06	633252.6	718923.6	6.8	24	-17.2

Notes:  
ft. AMSL: feet above mean sea-level

NOTES  
1. Ground surface elevations obtained from field survey data performed on behalf of CH2M HILL by Vargo Associates and lithology elevations were obtained from CH2M HILL boring logs for CH2M HILL sample locations. Ground surface and lithology elevations for Non-CH2M HILL locations obtained from boring logs from other consultants including GeoSyntec, EWMA, PMK Group, and GZA.

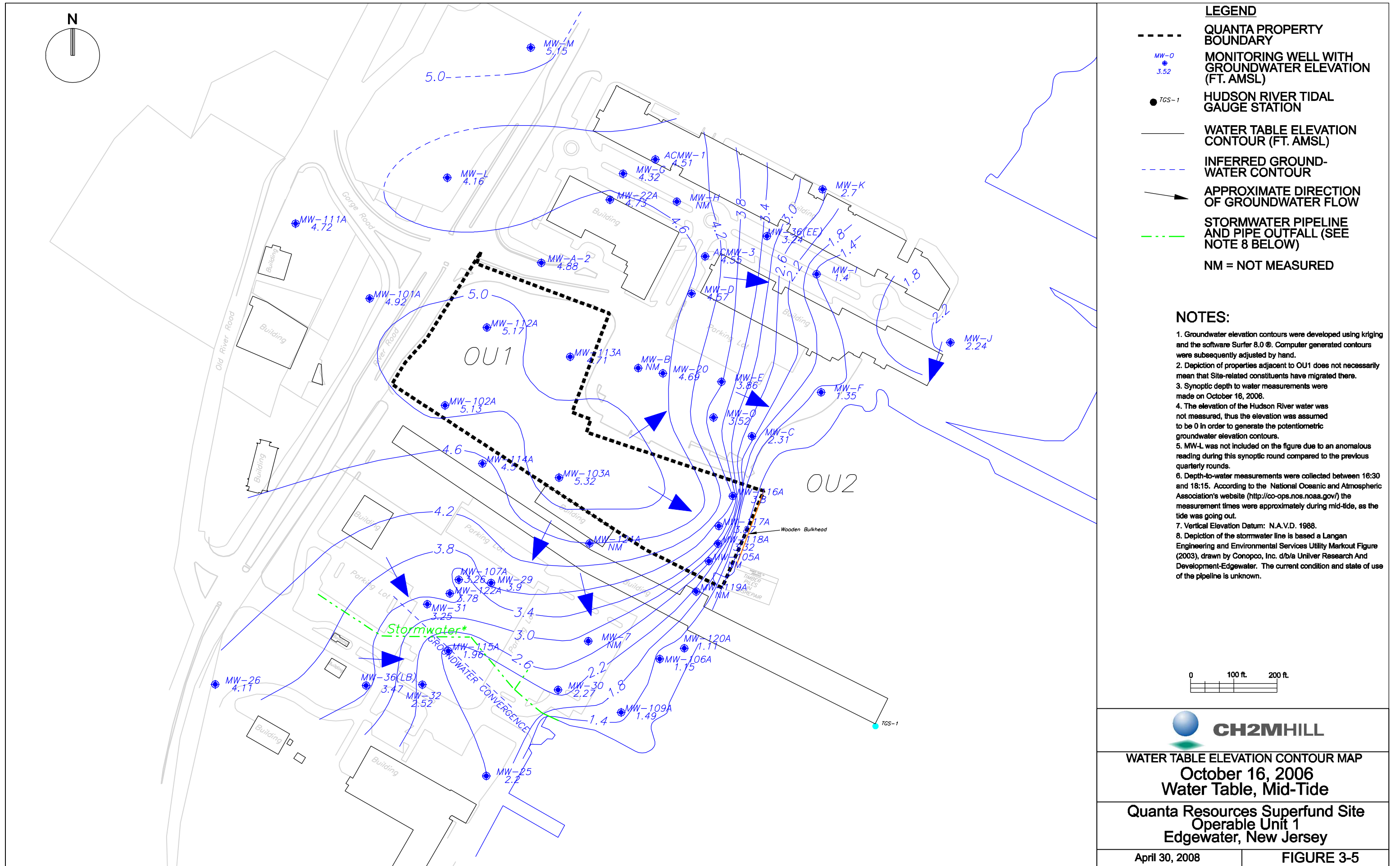
TOP OF BEDROCK  
ELEVATION CONTOUR MAP  
Quanta Resources Superfund Site  
Operable Unit 1  
Edgewater, New Jersey

June 26, 2008

FIGURE 3-4c

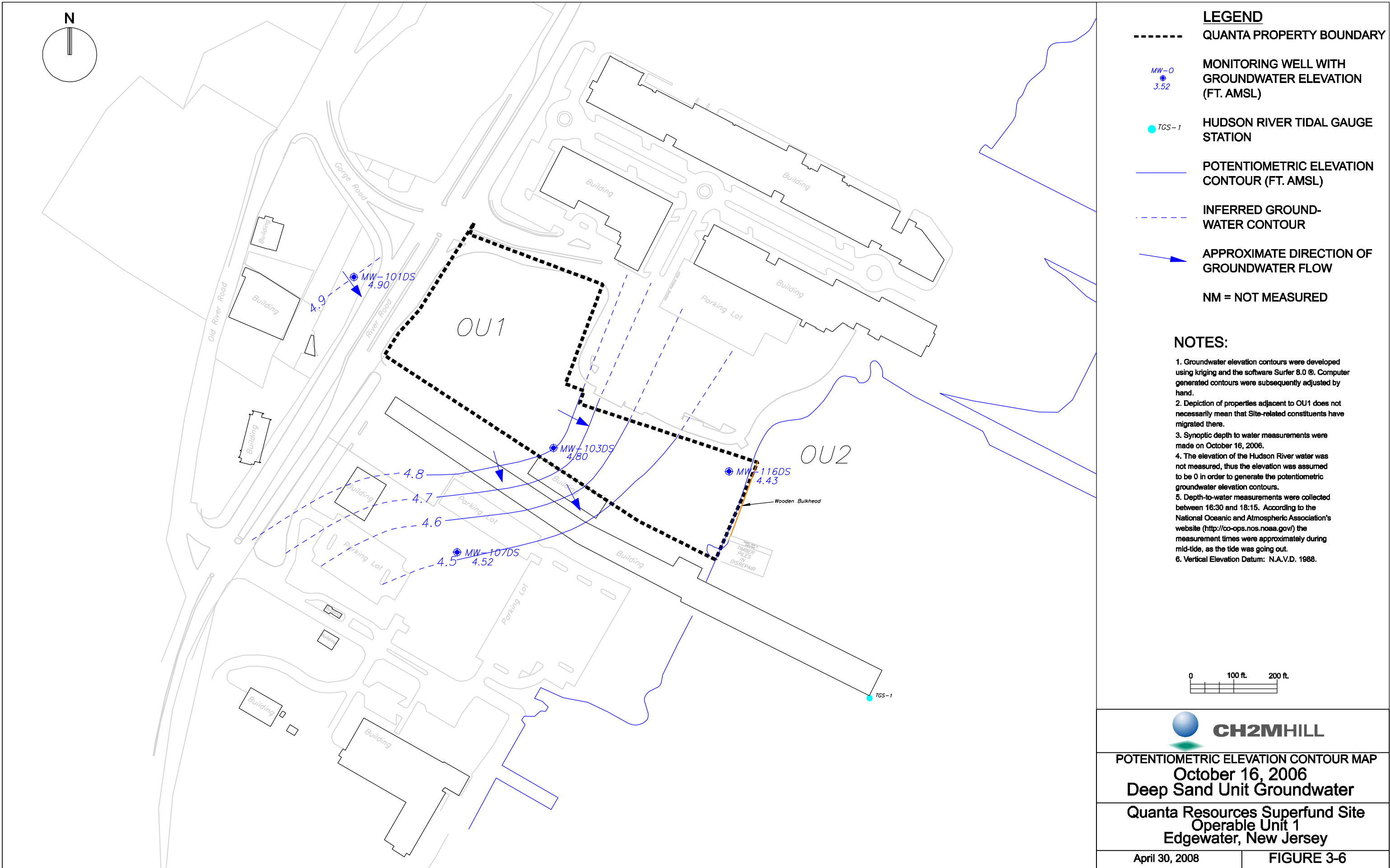
PLOT DATE: June 26, 2008 PLOT TIME: 16:15

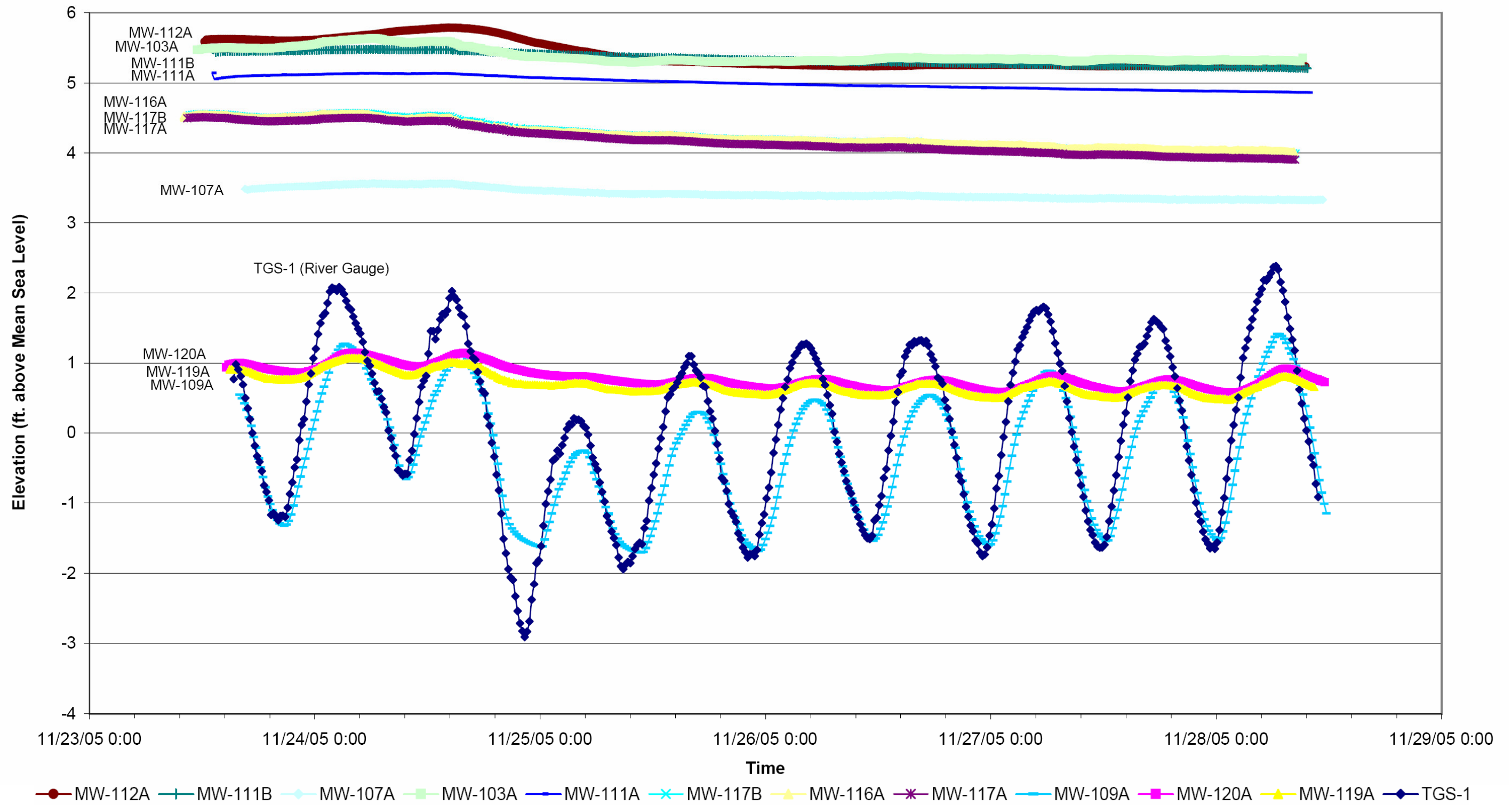
**Figure 3-5 is Superseded by Figure 3-16 of the Final SRI Report**





**Figure 3-6 is Superseded by Figure 3-15 of the Final SRI Report**





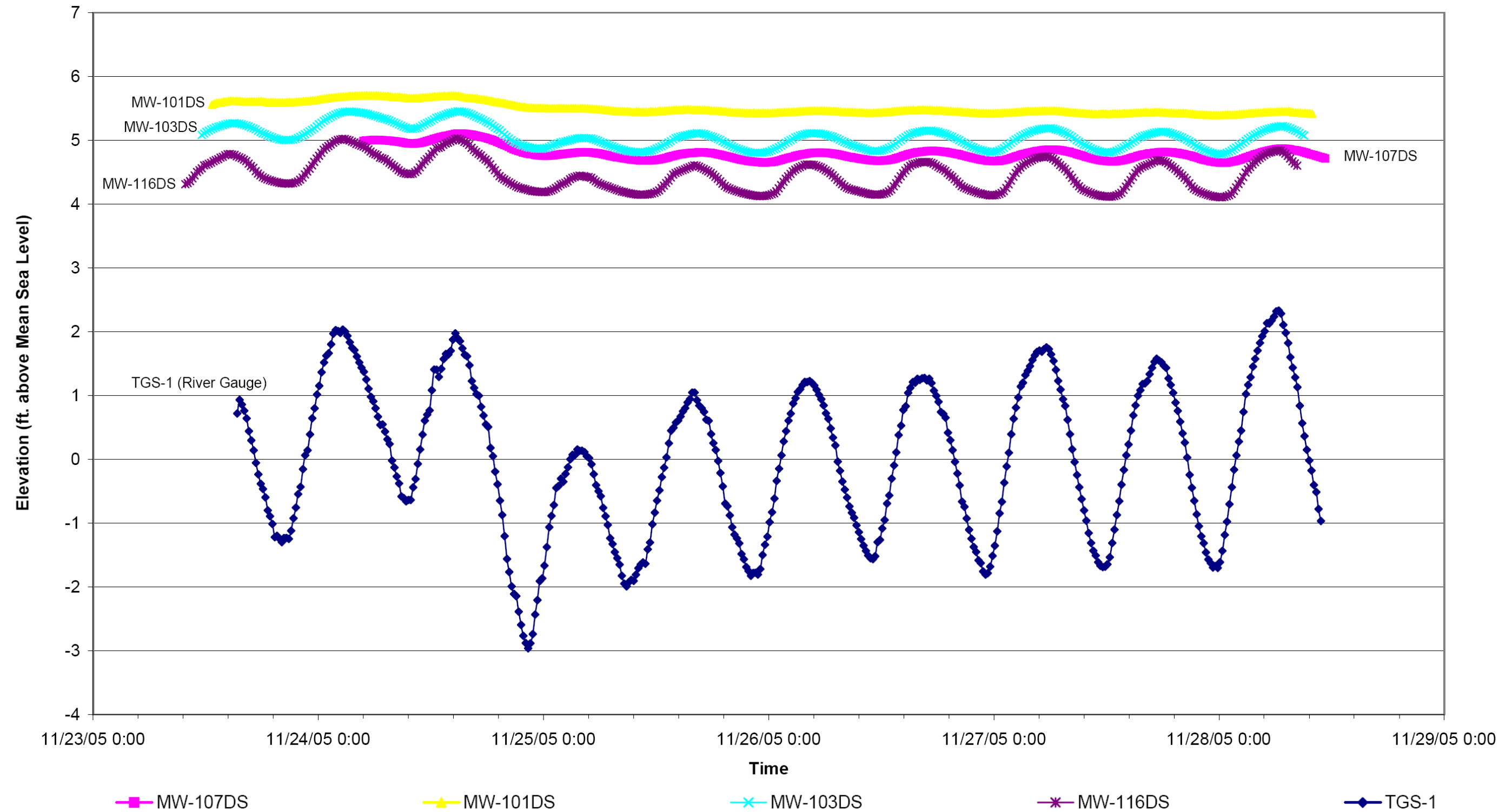
**TIDAL STUDY HYDROGRAPH SHALLOW  
GROUNDWATER MONITORING WELLS**


**Quanta Resources Superfund Site  
Operable Unit 1  
Edgewater, New Jersey**

October 23, 2007

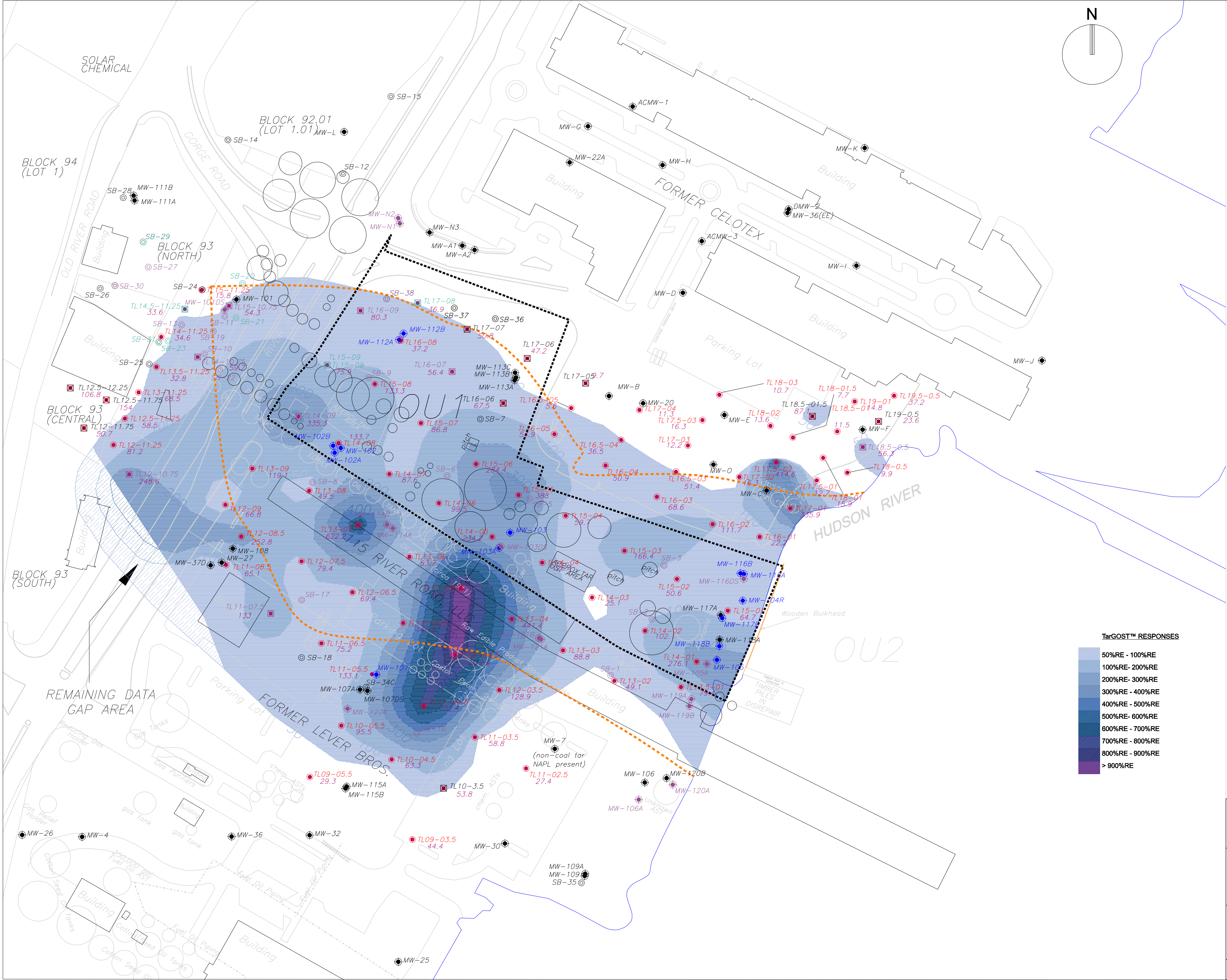
**FIGURE 3-7**

306264



	
<b>TIDAL STUDY HYDROGRAPH DEEP SAND UNIT GROUNDWATER MONITORING WELLS</b>	
<b>Quanta Resources Superfund Site Operable Unit 1 Edgewater, New Jersey</b>	
October 23, 2007	<b>FIGURE 3-8</b>





LEGEND

- EXISTING MONITORING WELL
- SOIL BORING
- MONITORING WELL WHERE NAPL HAS BEEN OBSERVED
- SOIL BORING WHERE NAPL HAS BEEN OBSERVED
- SOIL BORING WHERE HARD TAR HAS BEEN OBSERVED IN THE ABSENCE OF NAPL
- SI TarGOST® BORING LOCATION W/ MAX %RE
- SI TarGOST® BORING WITH SOIL SAMPLING & ANALYSIS W/ MAX %RE
- AREA WHERE NAPL IS INTERPOLATED (ADDITIONAL INFO REQUIRED TO CONFIRM)
- EXTENT OF "HEAVY-END PRODUCT" (ADAPTED FROM FIGURE 5-1 OF REMOVAL SITE INVESTIGATION REPORT (GeoSYNTEC, 2000B) ONLY THE UPLAND EXTENT IS DEPICTED]
- FORMER TANK AT ONE TIME CONTAINING TAR
- FORMER TANK NOT CONTAINING TAR
- QUANTA PROPERTY BOUNDARY

NOTES:

- TarGOST® results are reported as a percent of a reference emitter (%RE) that is used to calibrate the tool prior to the completion of each boring location.
- Depiction of other properties on this figure is for comparative purposes and does not necessarily suggest that Site-related constituents have migrated there.
- The extent of the 50%RE contour was modified to accommodate the following:
  - (a) false positive responses (>50%RE) that were the result of the presence of peat/meadow mat.
  - (b) coal tar that was not profiled with the TarGOST® tool due to piloting of holes in the upper few feet where product has historically been observed (Quanta property only)
- Potentially due to refusals the complete extent of NAPL in some areas within the southern portion of the former Celotex property NAPL was not detected at these locations using TarGOST®. The total extent of NAPL has been derived using a combination of TarGOST® and documented observations at soil sampling and monitoring well locations during the RI and as part of work performed at adjacent properties. This extent is depicted in Figure 4-4 of the Remedial Investigation Report (CH2M Hill, 2008).

Basemap Sources:  
a.) Boundary and topographic survey of Block 95, Lot 1 and Block 96, Lots 1, 2, and 3 performed by Varga Associates in September 2006 and updated as recently as June 2007.  
b.) Borough of Edgewater Tax Map - November, 1999  
c.) Coal Tar Engineering Design Report (Environ, July 2006)  
d.) Site Investigation Report, Part 4 (Langan, May 2004) for the former Lever Bros. Property.

TarGOST™ RESPONSES

- 50%RE - 100%RE
- 100%RE - 200%RE
- 200%RE - 300%RE
- 300%RE - 400%RE
- 400%RE - 500%RE
- 500%RE - 600%RE
- 600%RE - 700%RE
- 700%RE - 800%RE
- 800%RE - 900%RE
- > 900%RE

GRAPHIC SCALE

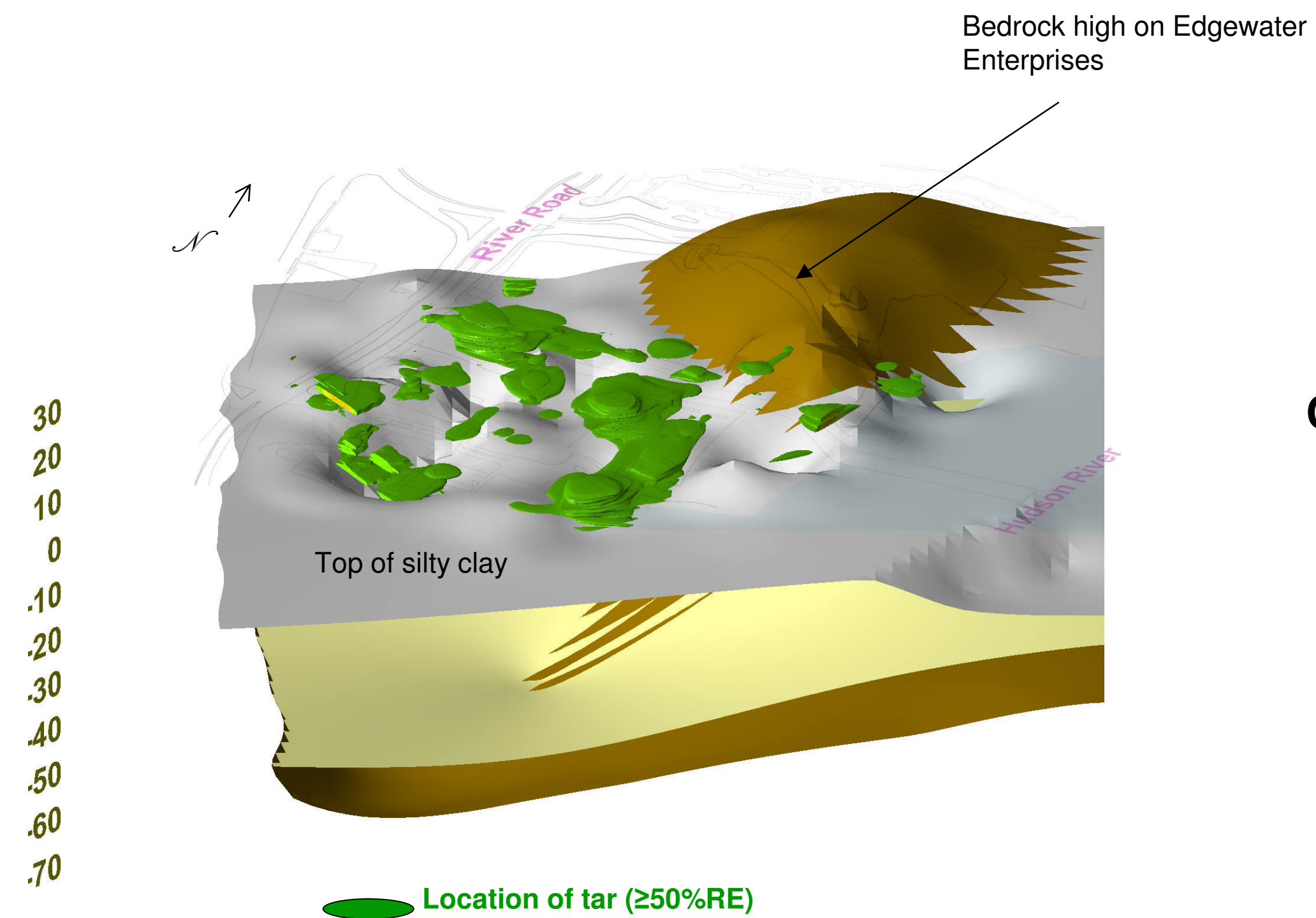
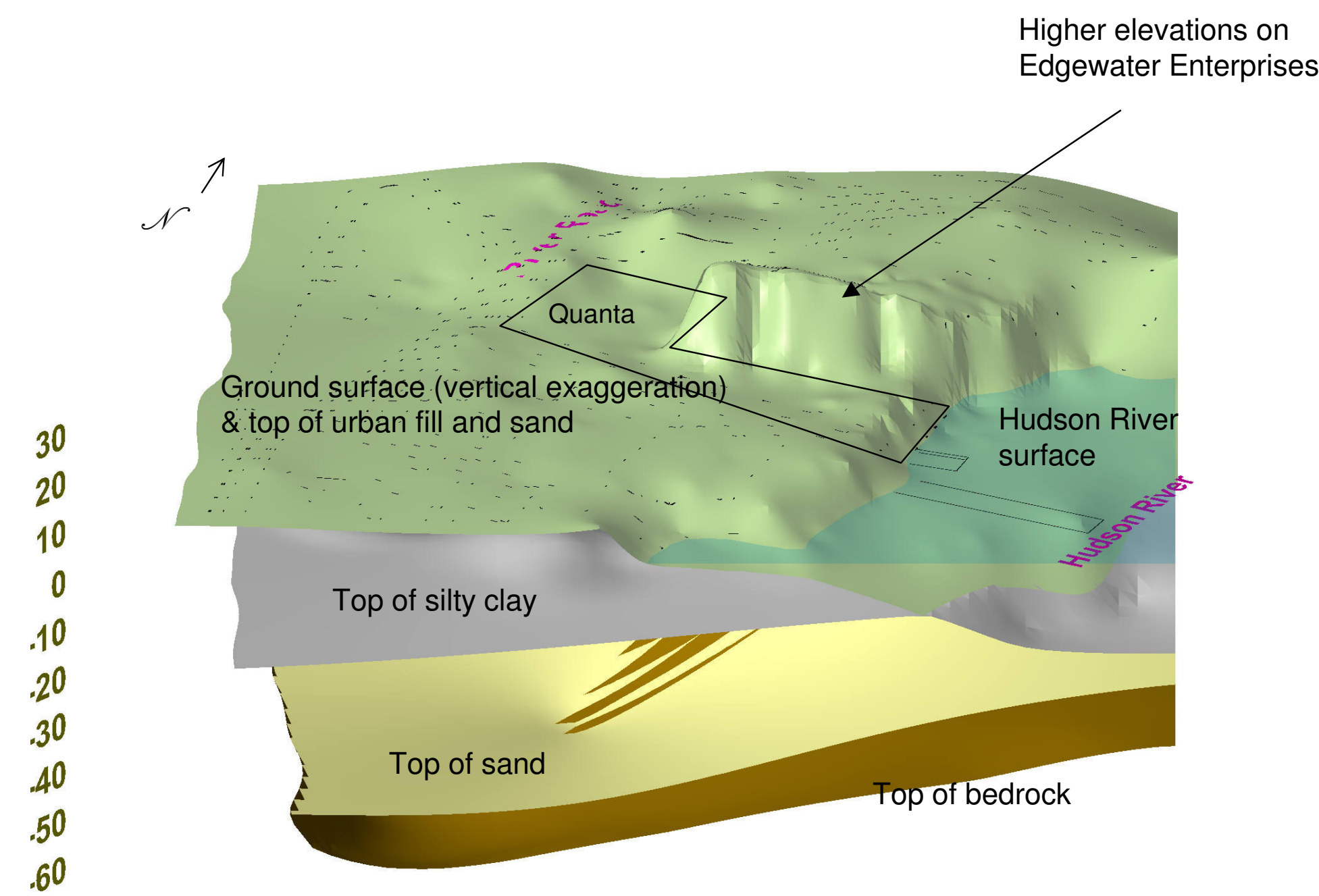


MAXIMUM TarGOST®  
RESPONSE CONTOURING  
Quanta Resources Superfund Site  
Operable Unit 1  
Edgewater, New Jersey

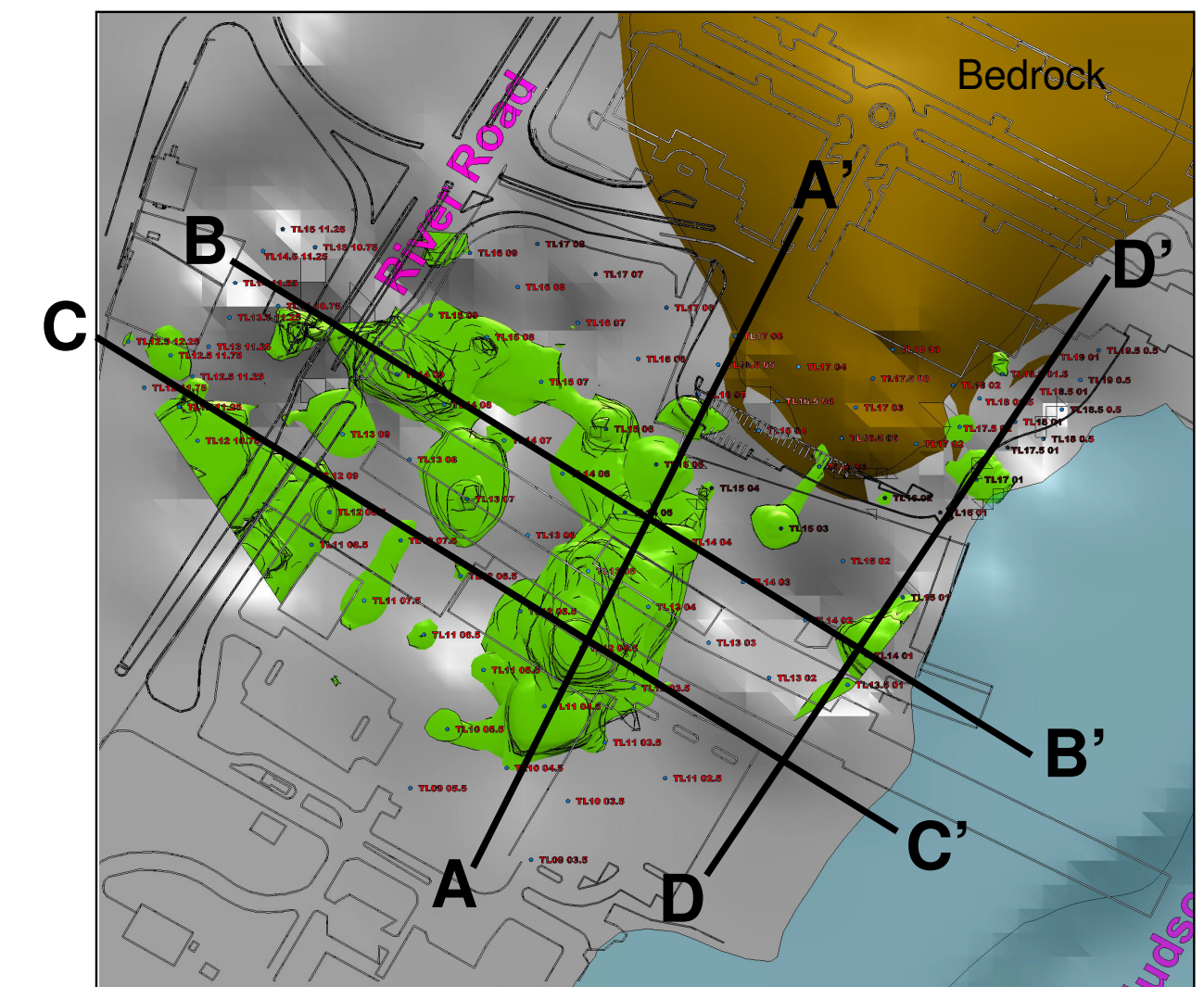
June 3, 2008

FIGURE 4-1

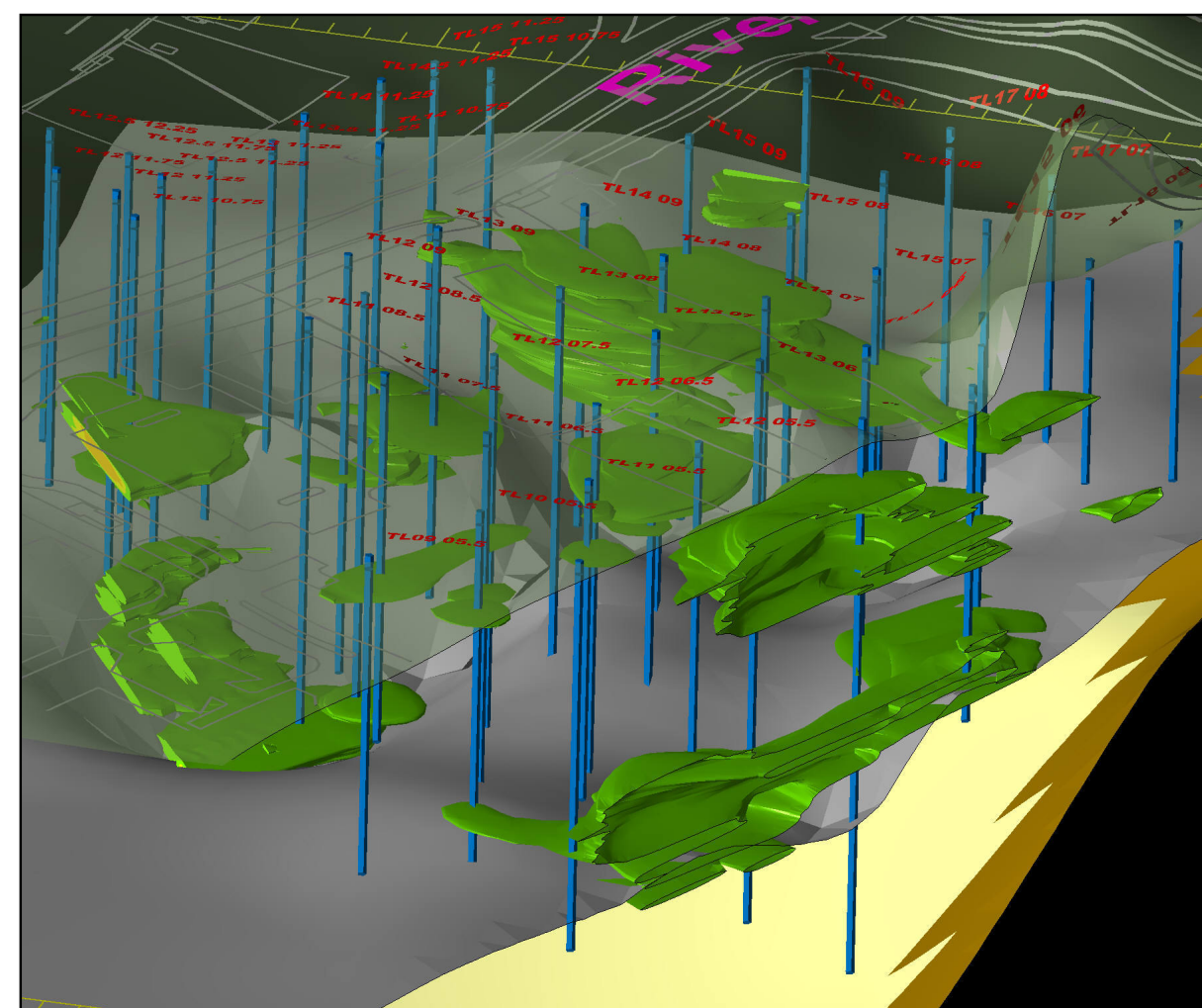




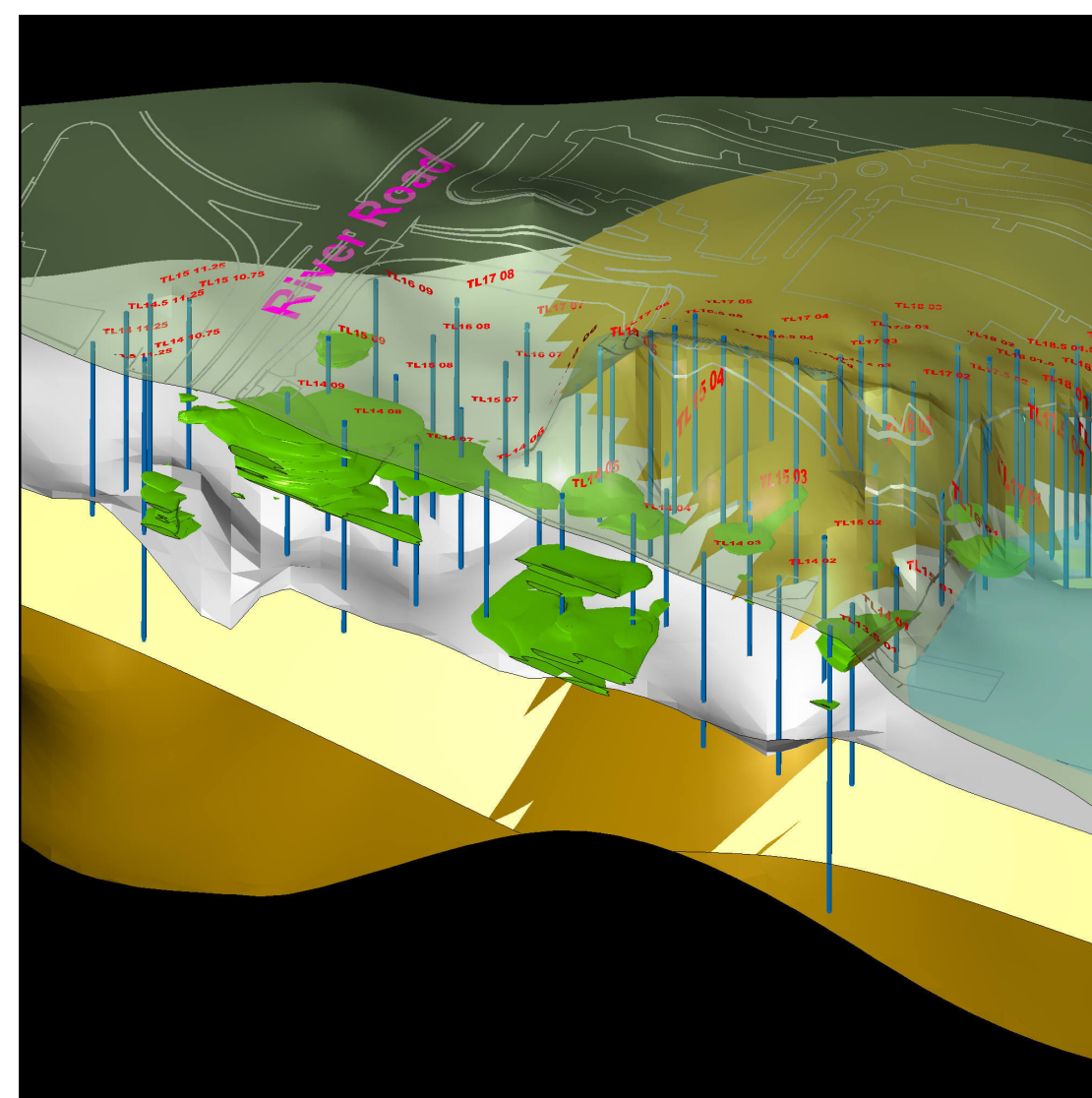
3D Model Cross Section Locations (plan view)



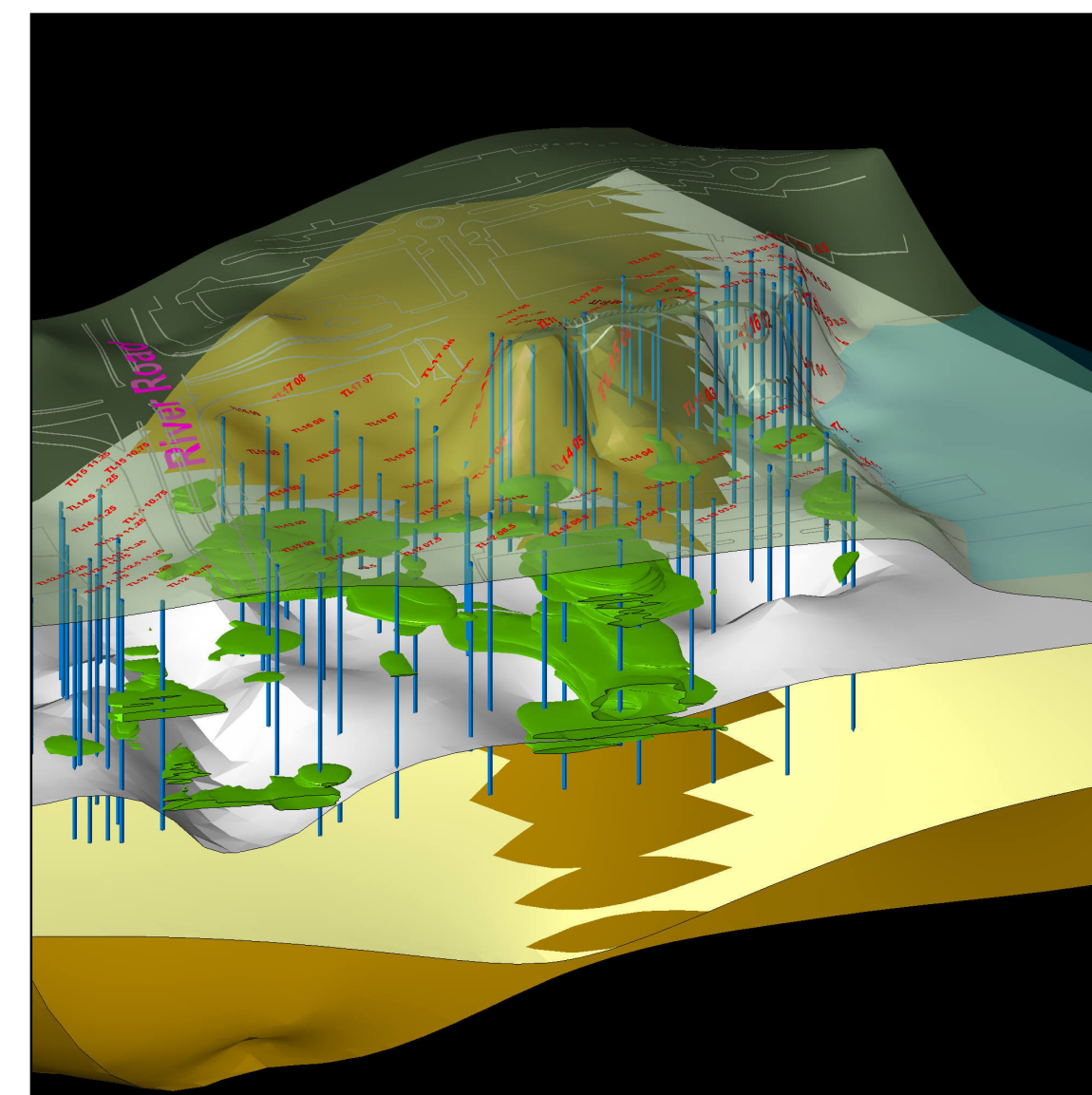
**Cross Section A – A'**  
Parallel to Hudson River,  
Center of Site



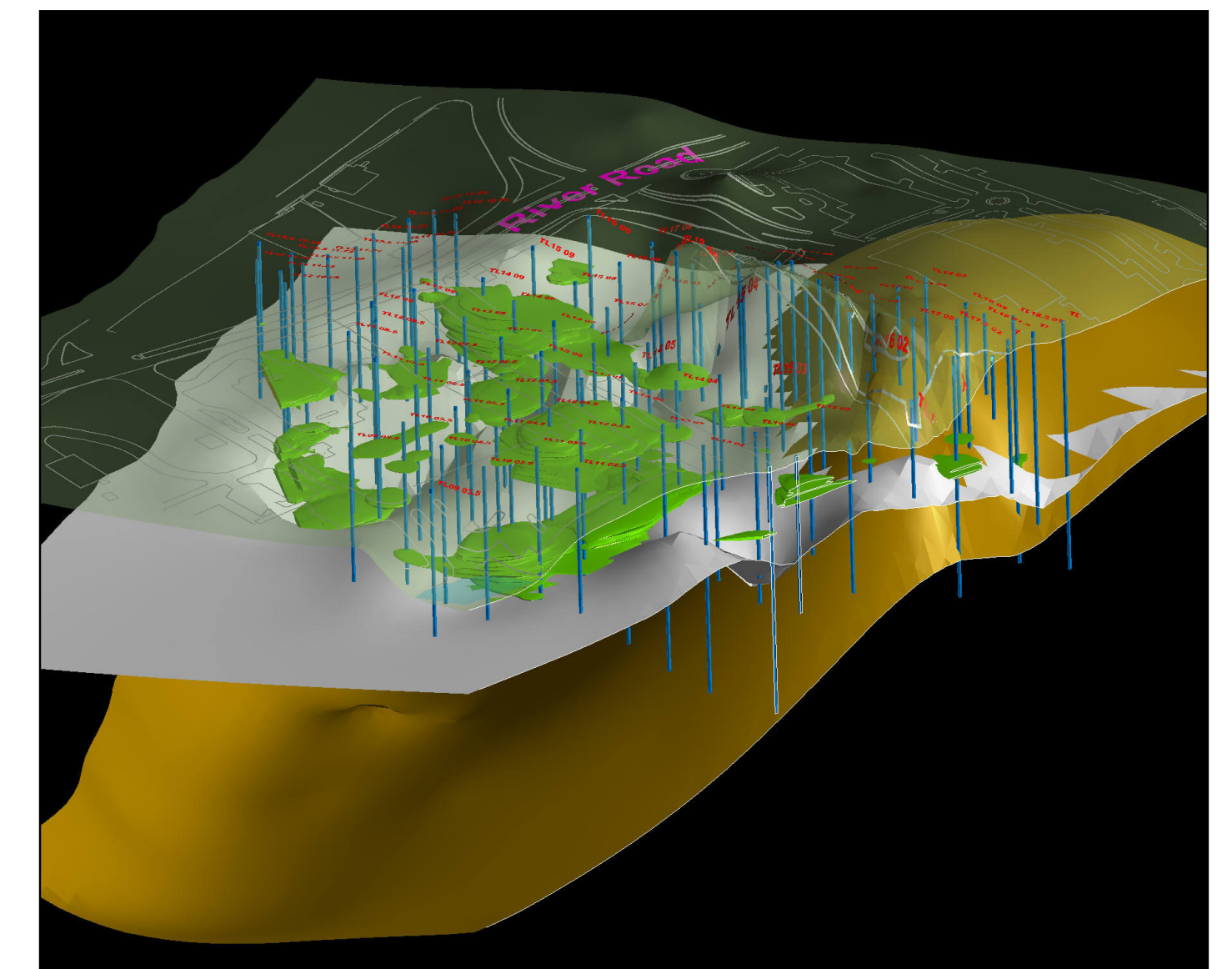
**Cross Section B – B'**  
Quanta - 115 River Road  
Property Line



**Cross Section C – C'**  
115 River Road – Lever Bros.  
Property Line



**Cross Section D – D'**  
Hudson River Shoreline



Notes: The cross-sections presented here are based on different transects than the geologic cross-sections presented in Figures 3-3 and 3-4.



**VIEWS OF 3D GEOLOGIC MODEL  
WITH COAL TAR EXTENTS**

Quanta Resources Superfund Site  
Operable Unit 1  
Edgewater, New Jersey

August 20, 2007

**FIGURE 4-2**



**Figure 4-3 is Superseded by Figures 3-1 – 3-7 of the Final SRI Report**

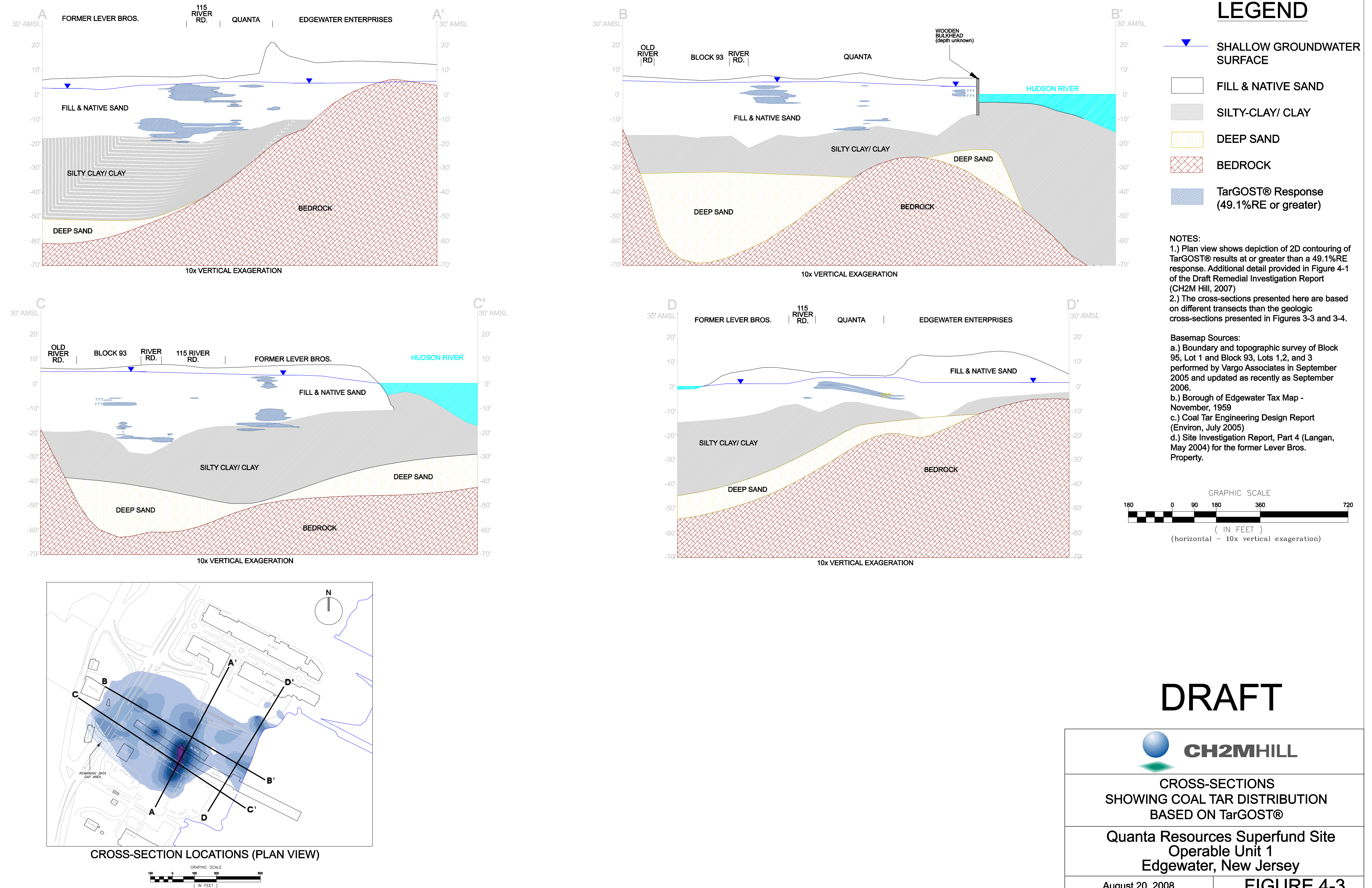
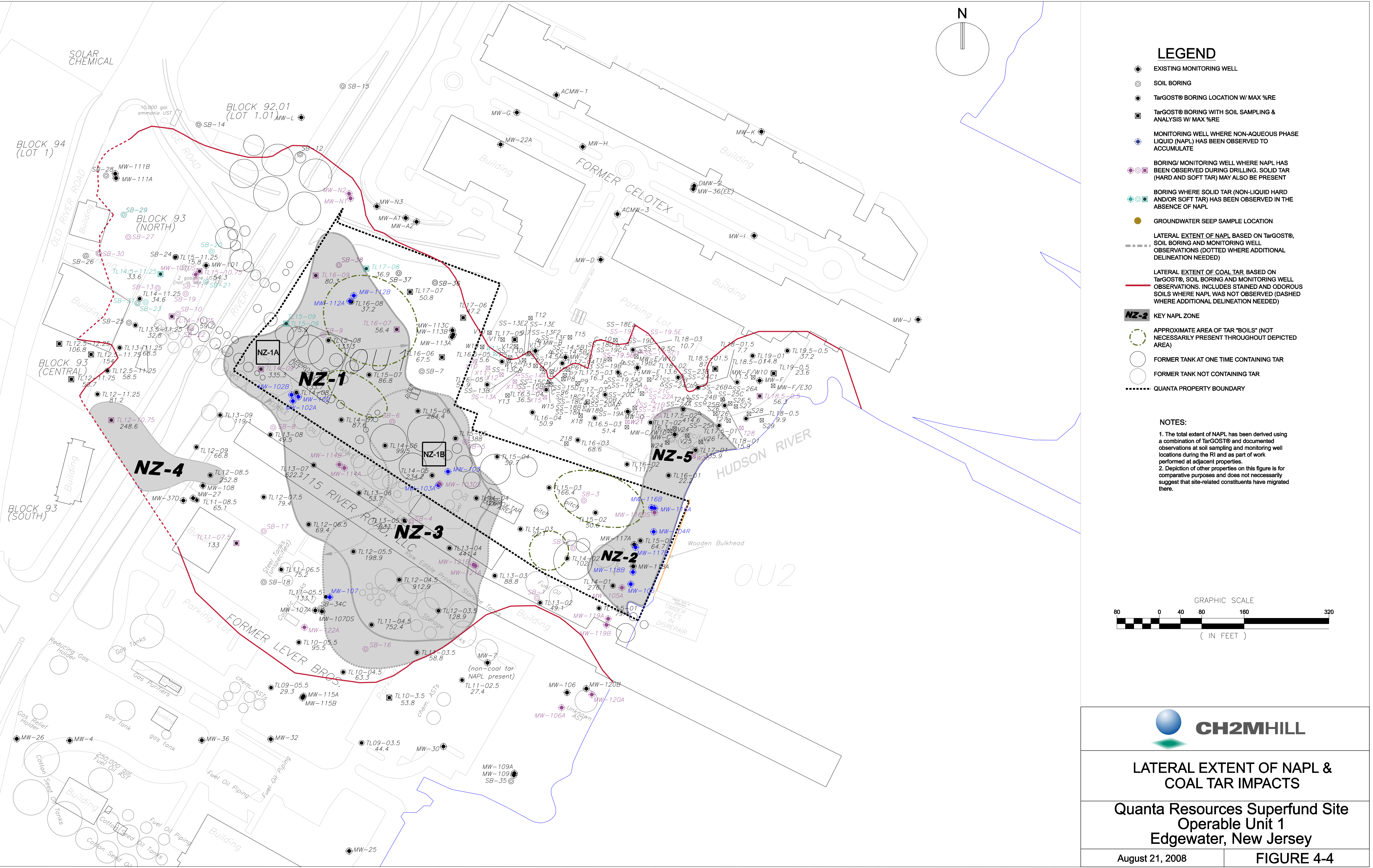
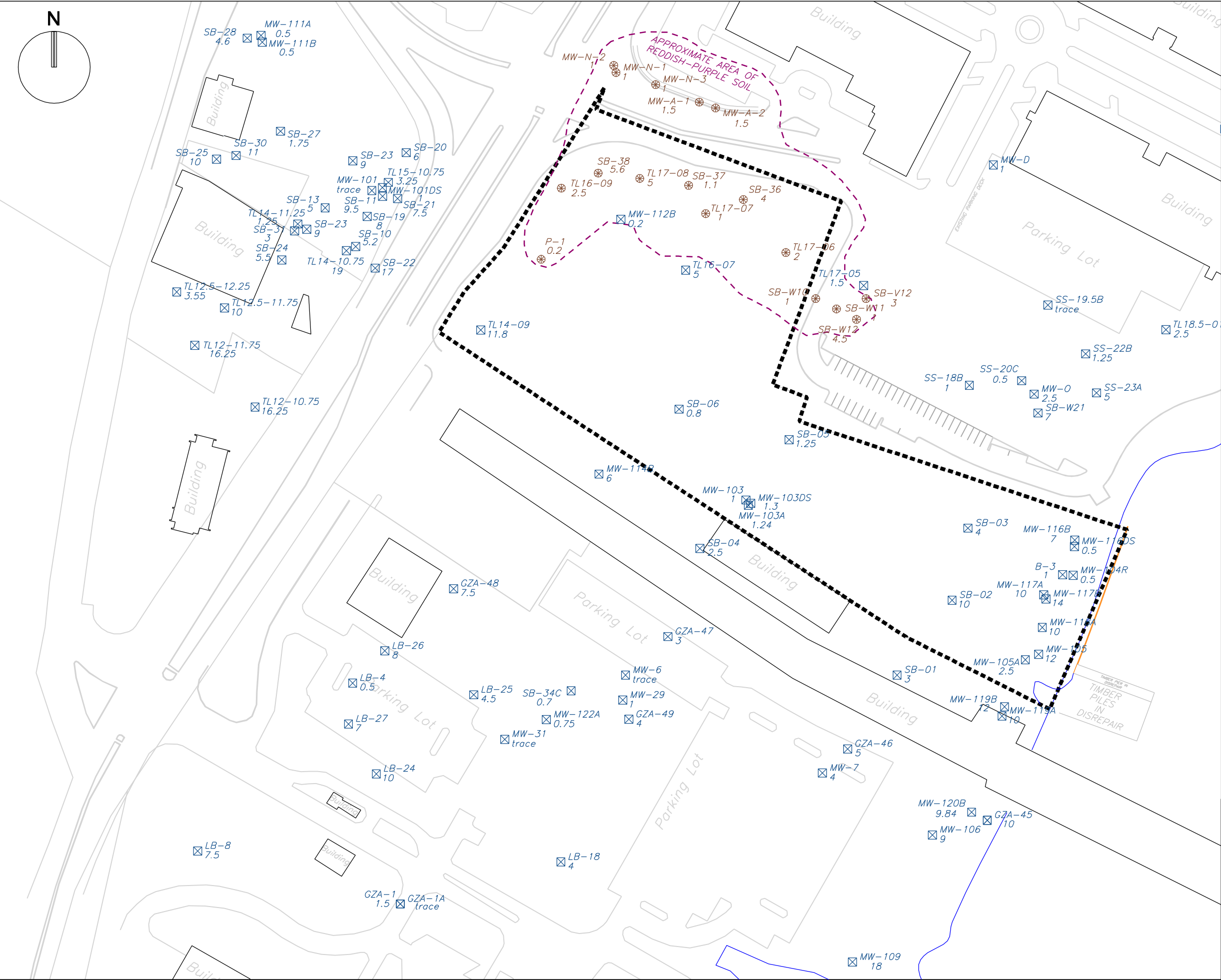







Figure 4-4 is Superseded by Figure 3-8 of the Final SRI Report







# LEGEND

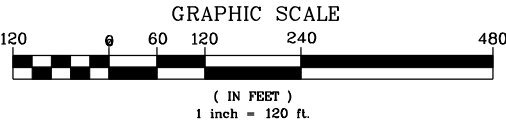
-  SB-02 10 BORING LOCATION WITH INTERVAL OF SLAG-RICH FILL DEPOSITS OBSERVED (FT.)
-  TL17-07 1 BORING LOCATION WITH INTERVAL OF REDDISH-PURPLE SOILS OBSERVED
-  CURRENT QUANTA PROPERTY BOUNDARY

**NOTES:**

1. The extent of reddish-purple soil is based on observations and soil sampling results from extensive borings and soil sampling programs performed at the former Celotex property, the Quanta property, and to the west within River Road and beyond. Due to the large number of soil observations all locations could not be shown on this figure.

2. Depiction of other properties on this figure is for comparative purposes and does not necessarily suggest that site-related constituents have migrated there.

- Basemap Sources:**
- a.) Boundary and topographic survey of Block 95, Lot 1 and Block 93, Lots 1,2, and 3 performed by Vargo Associates in September 2005 and updated as recently as June 2007.
  - b.) Borough of Edgewater Tax Map - November, 1959.
  - c.) Coal Tar Engineering Design Report (Environ, July 2005).
  - d.) Site Investigation Report, Part 4 (Langan, May 2004) for the former Lever Bros. Property.



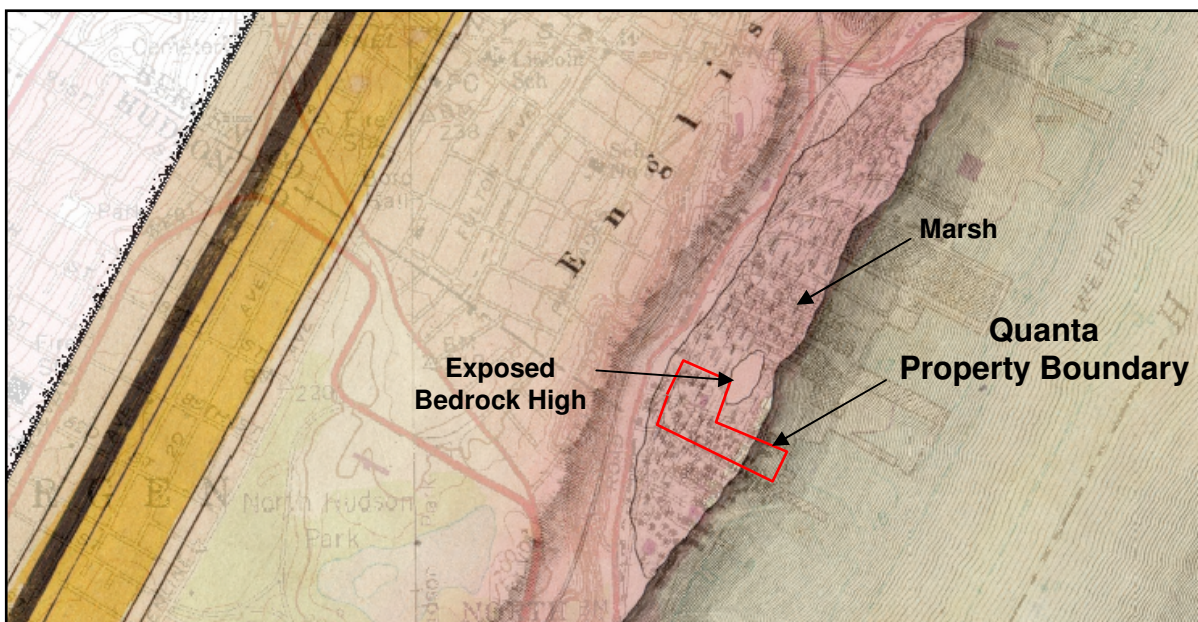
Cinder/Ash and  
Reddish-Purple Soils Locations

Quanta Resources Superfund Site  
Edgewater, New Jersey

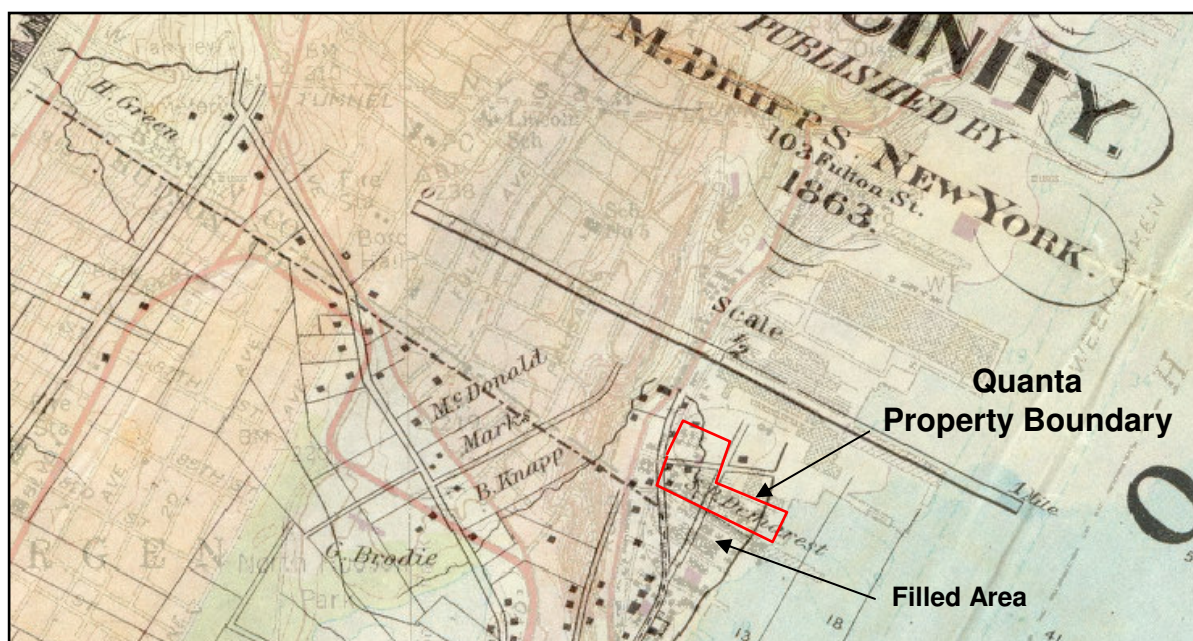
August 20, 2007

FIGURE 4-5

## Prior to Filling - 1832, Burr



## Following Filling - 1863, Dripps



### Note:

Manufacturing operations (coal tar, paving, and roofing materials) occurred at the Site from 1876 to 1967.

### Map Sources:

historic maps: <http://www.davidrumsey.com/>

background map: USGS, New York, New York 7.5 Min Quad, 1992



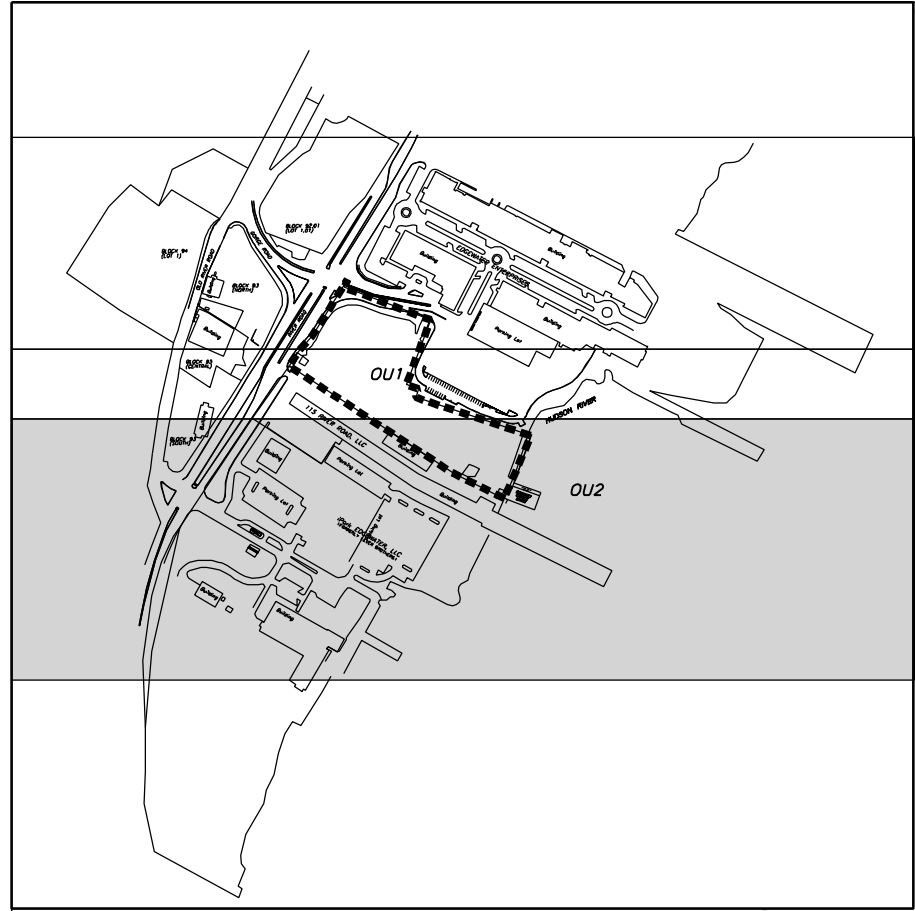
### HISTORICAL MAPS AND WETLAND FILLING

Quanta Resources Superfund Site  
Operable Unit 1  
Edgewater, New Jersey

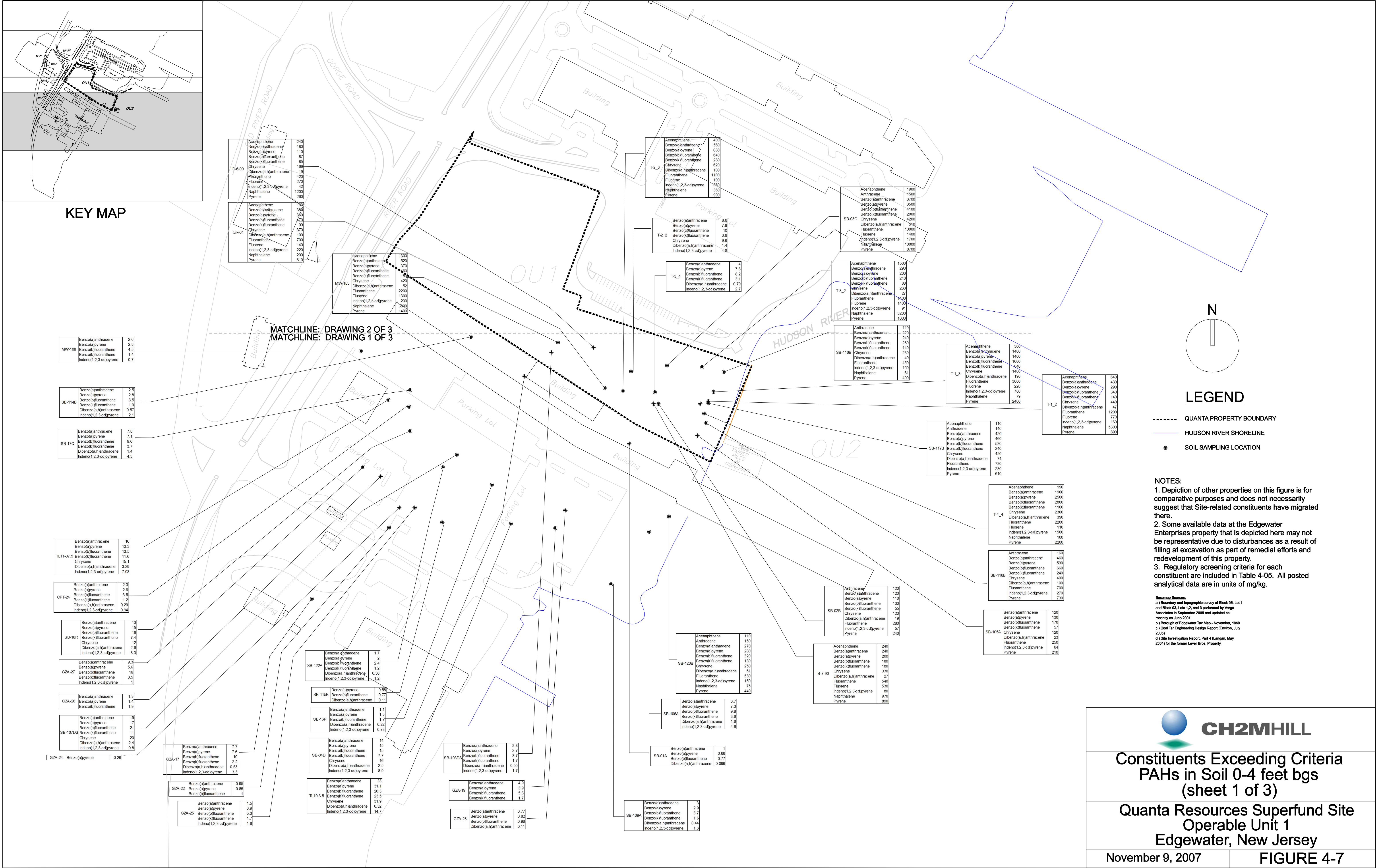
November 9, 2007

**FIGURE 4-6**

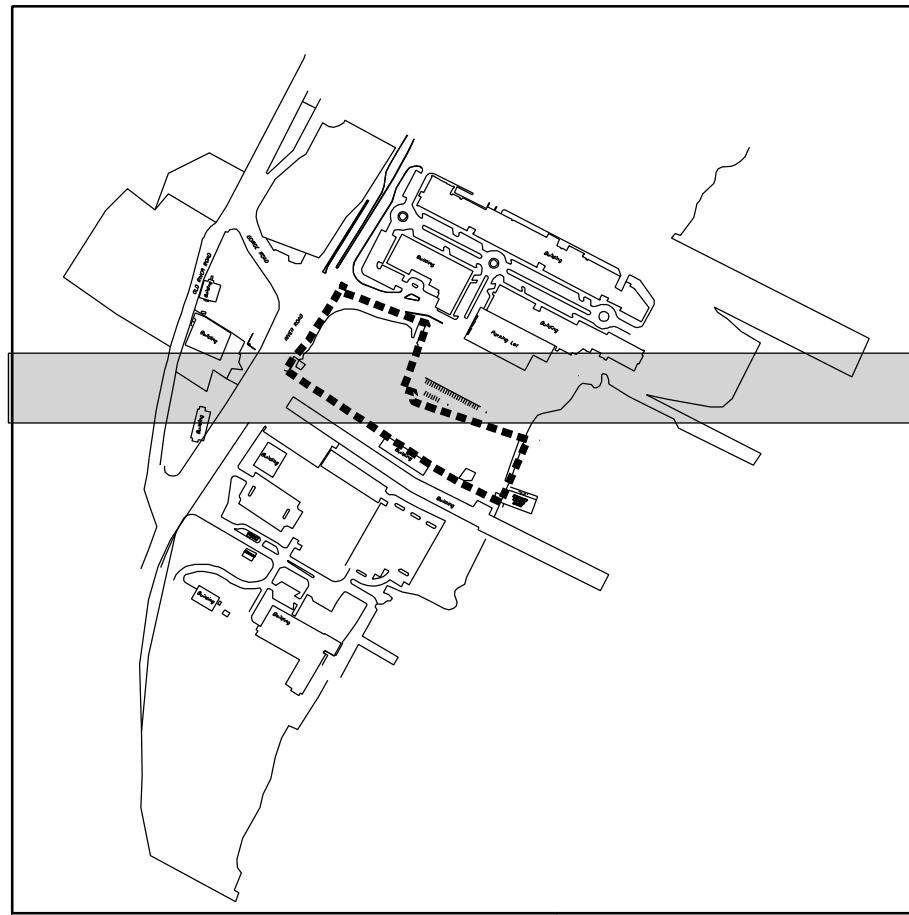




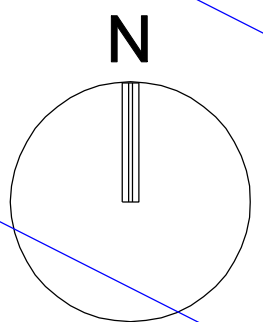
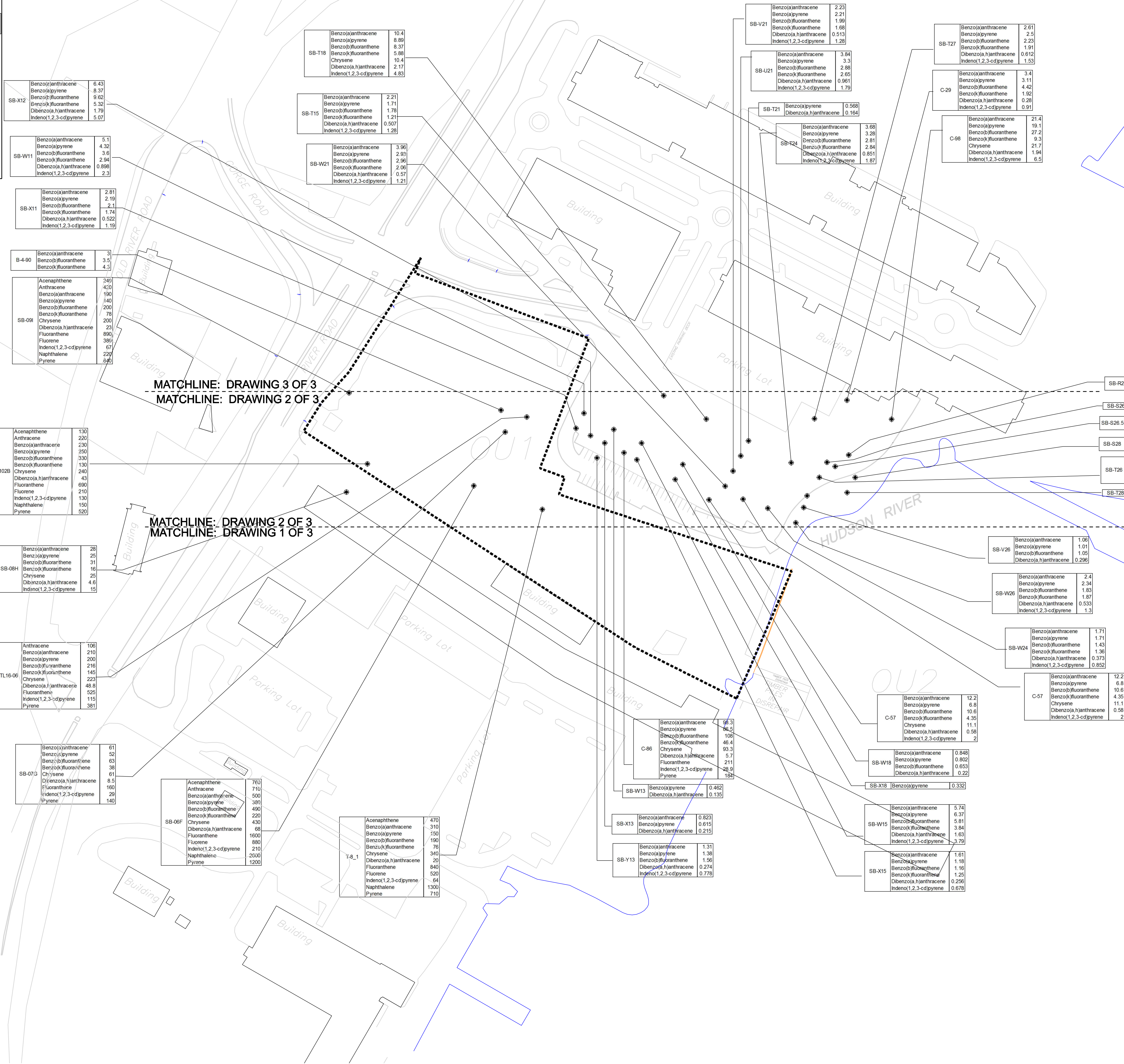
KEY MAP







KEY MAP



LEGEND

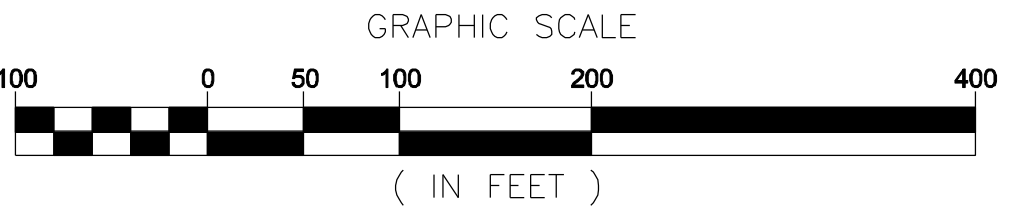
- QUANTA PROPERTY BOUNDARY
- HUDSON RIVER SHORELINE
- SOIL SAMPLING LOCATION

NOTES:

- Depiction of other properties on this figure is for comparative purposes and does not necessarily suggest that Site-related constituents have migrated there.
- Some available data at the Edgewater Enterprises property that is depicted here may not be representative due to disturbances as a result of filling at excavation as part of remedial efforts and redevelopment of this property.
- Regulatory screening criteria for each constituent are included in Table 4-05. All posted analytical data are in units of mg/kg.

Basemap Sources:

- Boundary and topographic survey of Block 95, Lot 1 and Block 95, Lots 1, 2, and 3 performed by Vargo Associates in September 2005 and updated as recently as June 2007.
- Borough of Edgewater Tax Map - November, 1999
- Coal Tar Engineering Design Report (Environ, July 2000)
- Site Investigation Report, Part 4 (Langen, May 2004) for the former Lever Bros. Property.



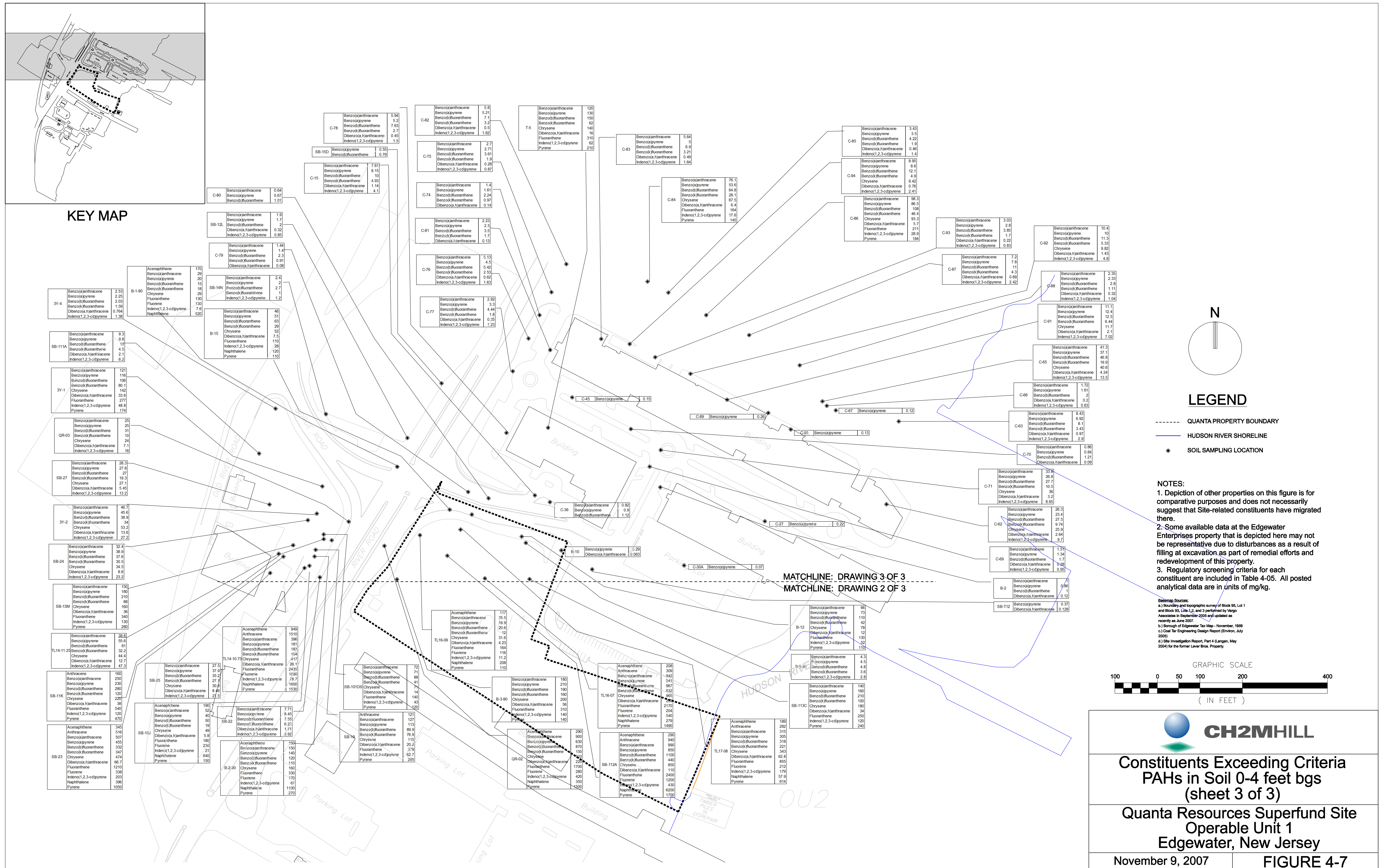
Constituents Exceeding Criteria  
PAHs in Soil 0-4 feet bgs  
(sheet 2 of 3)

Quanta Resources Superfund Site  
Operable Unit 1  
Edgewater, New Jersey

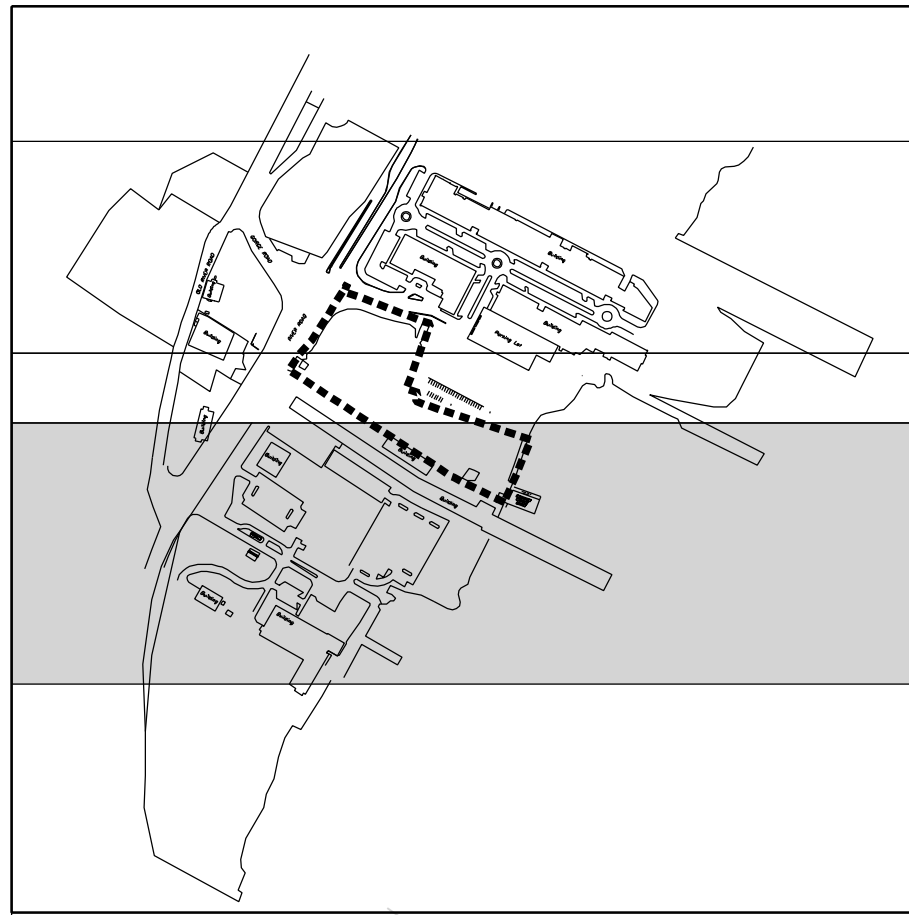
November 9, 2007

FIGURE 4-7

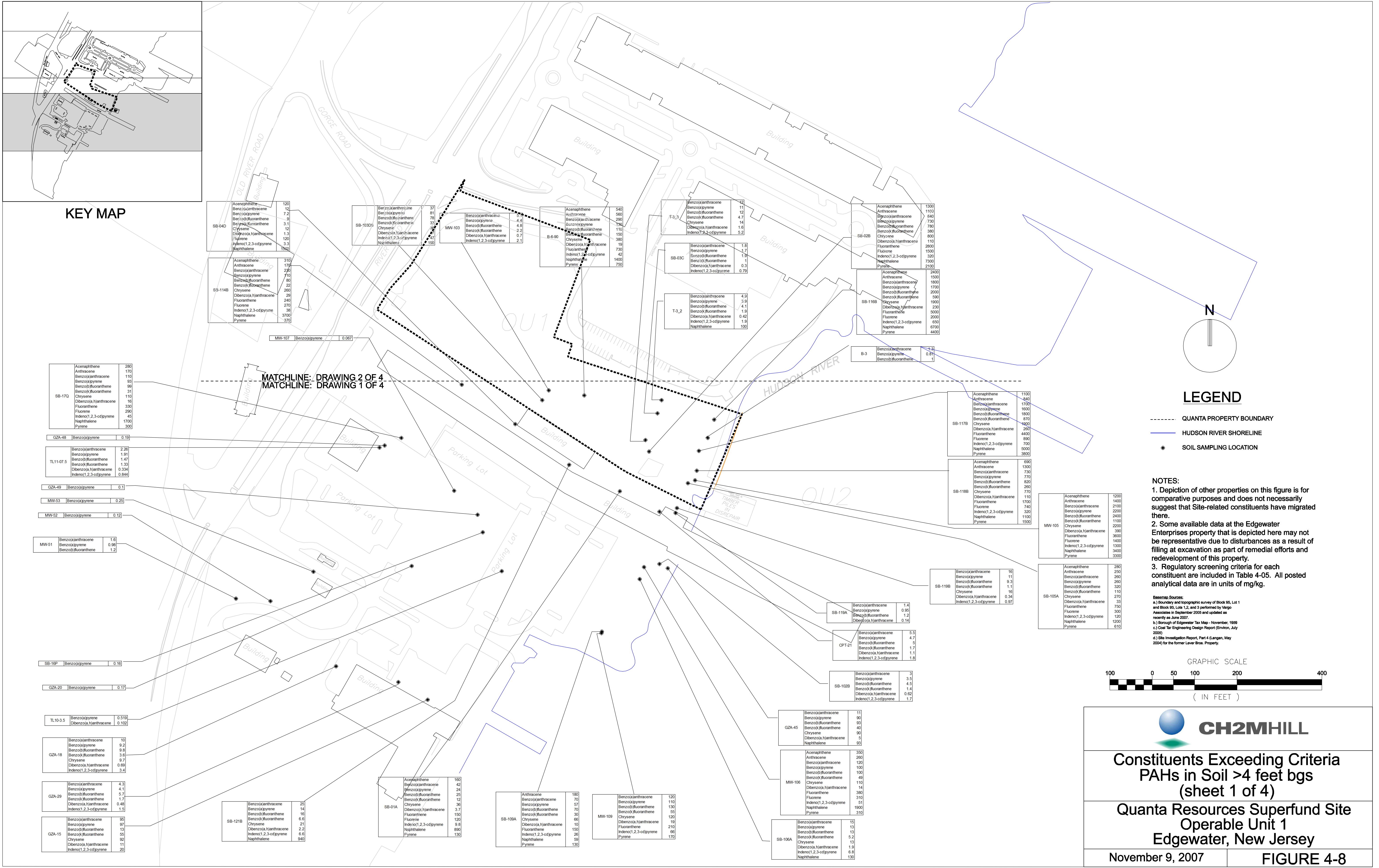




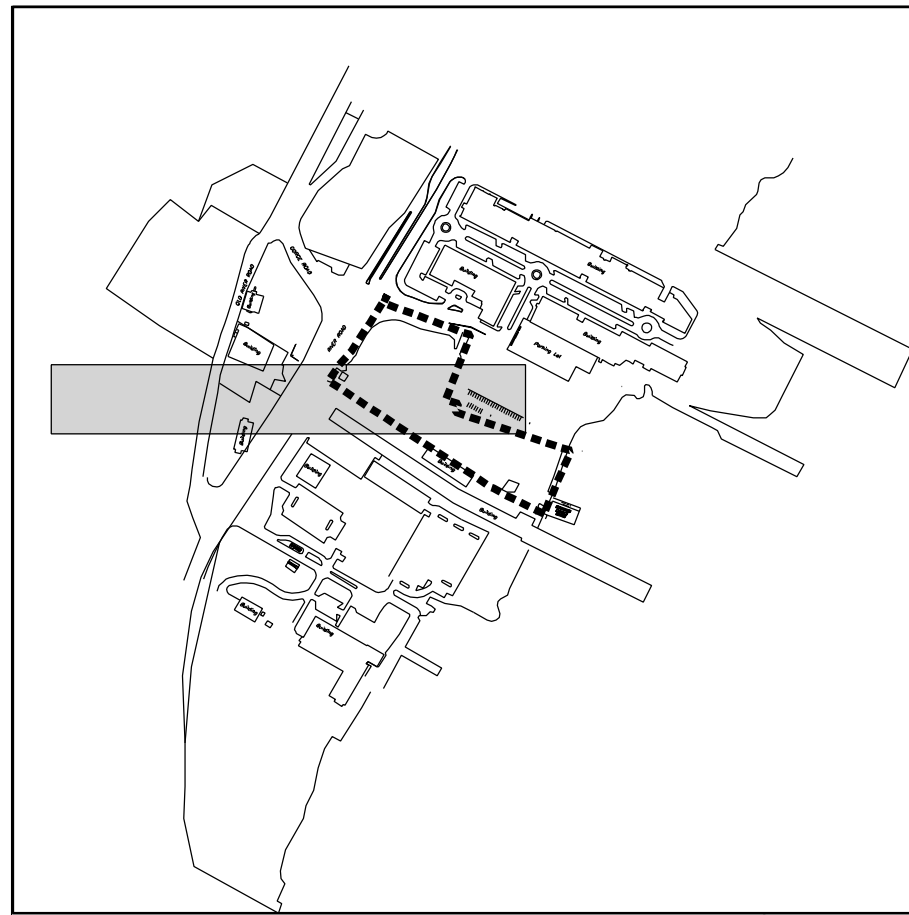




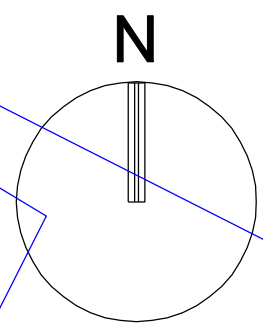
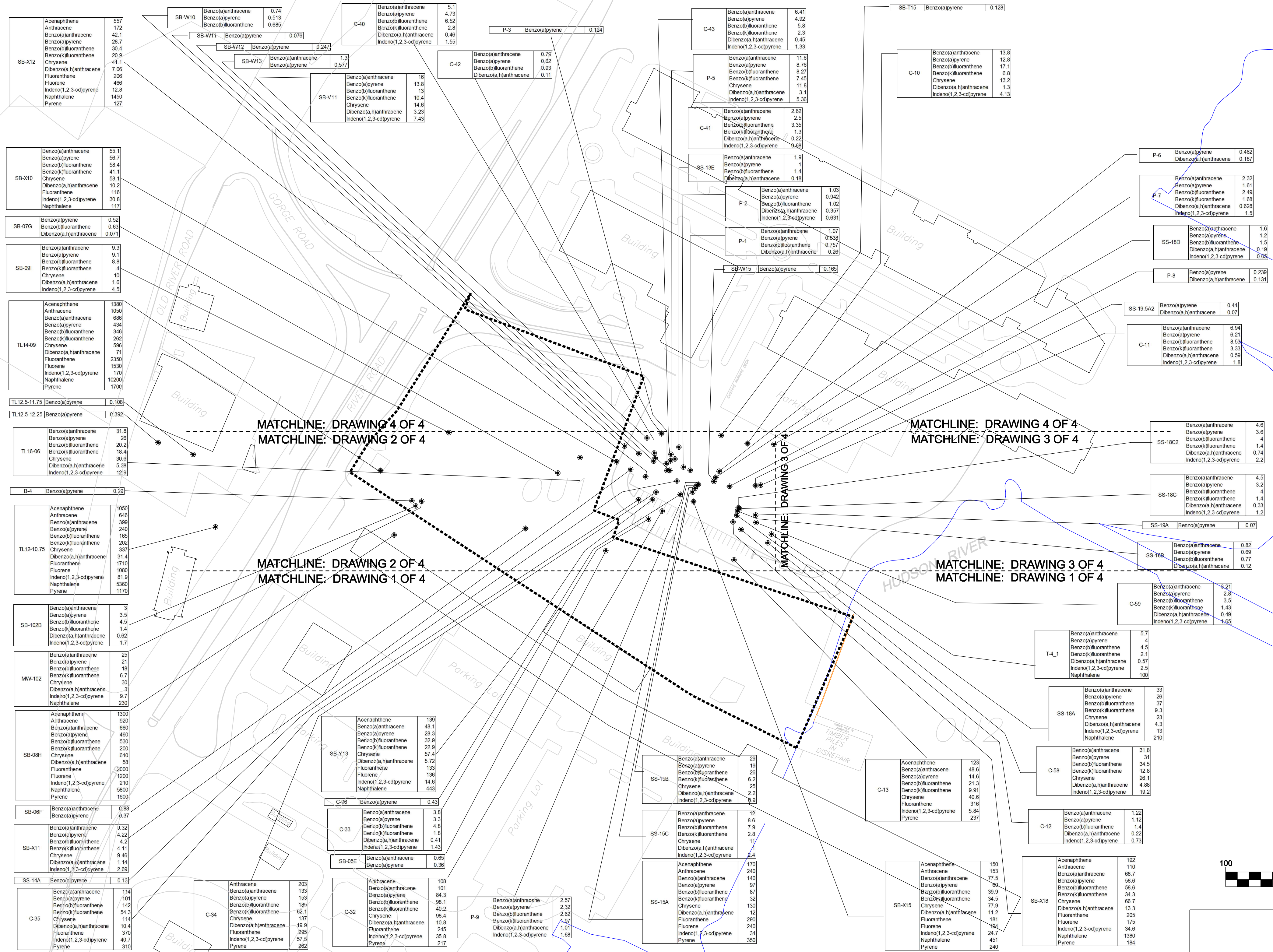
KEY MAP







## KEY MAP

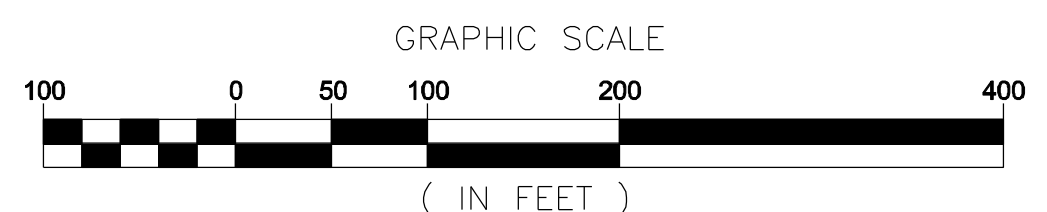


## LEGEND

- QUANTA PROPERTY BOUNDARY
- HUDSON RIVER SHORELINE
- SOIL SAMPLING LOCATION

- NOTES:
- Depiction of other properties on this figure is for comparative purposes and does not necessarily suggest that Site-related constituents have migrated there.
  - Some available data at the Edgewater Enterprises property that is depicted here may not be representative due to disturbances as a result of filling at excavation as part of remedial efforts and redevelopment of this property.
  - Regulatory screening criteria for each constituent are included in Table 4-05. All posted analytical data are in units of mg/kg.

Basemap Sources:  
a) Boundary and topographic survey of Block 95, Lot 1 and Block 93, Lots 1, 2, and 3 performed by Vargo Associates in September 2005 and updated as recently as June 2007.  
b) Borough of Edgewater Tax Map - November, 1999  
c) Coal Tar Engineering Design Report (Environ, July 2000)  
d) Site Investigation Report, Part 4 (Langen, May 2004) for the former Lever Bros. Property.



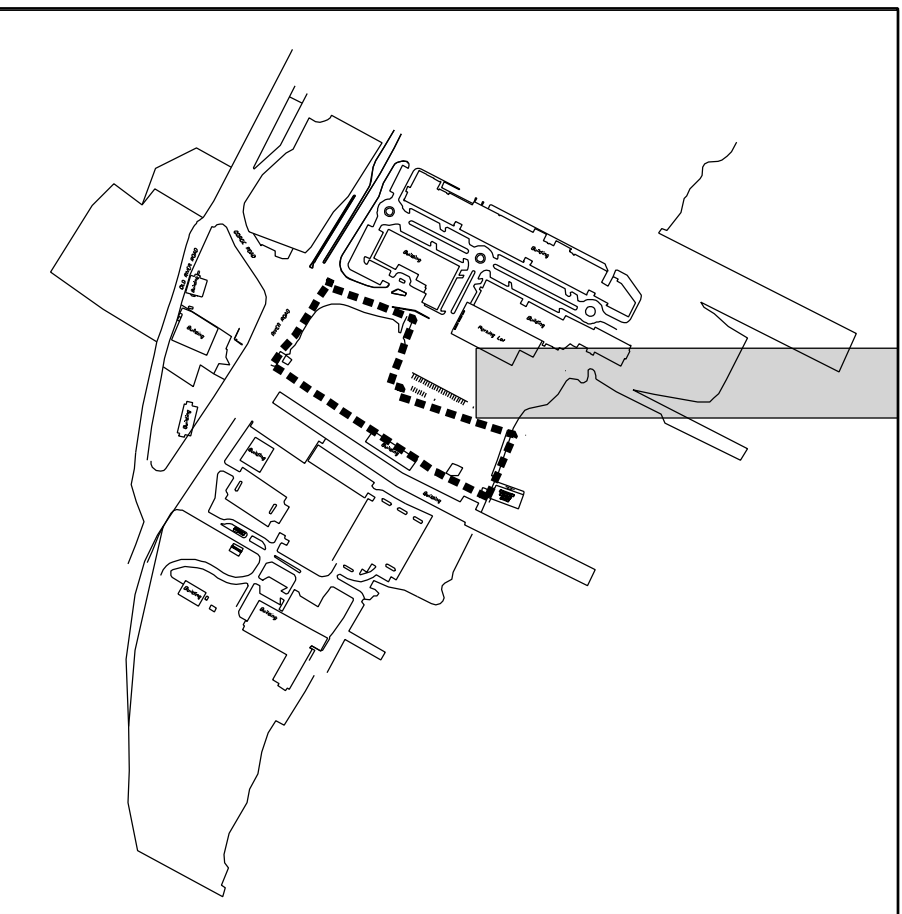
### Constituents Exceeding Criteria PAHs in Soil > 4 feet bgs (sheet 2 of 4)

### Quanta Resources Superfund Site Operable Unit 1 Edgewater, New Jersey

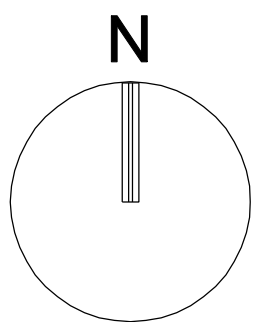
November 9, 2007

FIGURE 4-8





KEY MAP



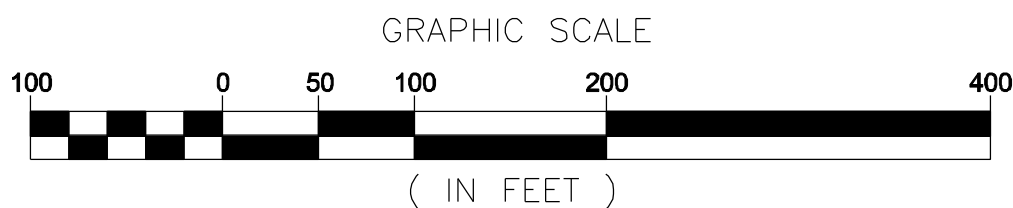
LEGEND

- QUANTA PROPERTY BOUNDARY
- HUDSON RIVER SHORELINE
- \* SOIL SAMPLING LOCATION

NOTES:

1. Depiction of other properties on this figure is for comparative purposes and does not necessarily suggest that Site-related constituents have migrated there.
2. Some available data at the Edgewater Enterprises property that is depicted here may not be representative due to disturbances as a result of filling at excavation as part of remedial efforts and redevelopment of this property.
3. Regulatory screening criteria for each constituent are included in Table 4-05. All posted analytical data are in units of mg/kg.

Basemap Sources:  
a.) Boundary and topographic survey of Block 95, Lot 1 and Block 95, Lots 1, 2, and 3 performed by Vargo Associates in September 2005 and updated as recently as June 2007.  
b.) Borough of Edgewater Tax Map - November, 1999  
c.) Coal Tar Engineering Design Report (Environ, July 2000)  
d.) Site Investigation Report, Part 4 (Langen, May 2004) for the former Lever Bros. Property.

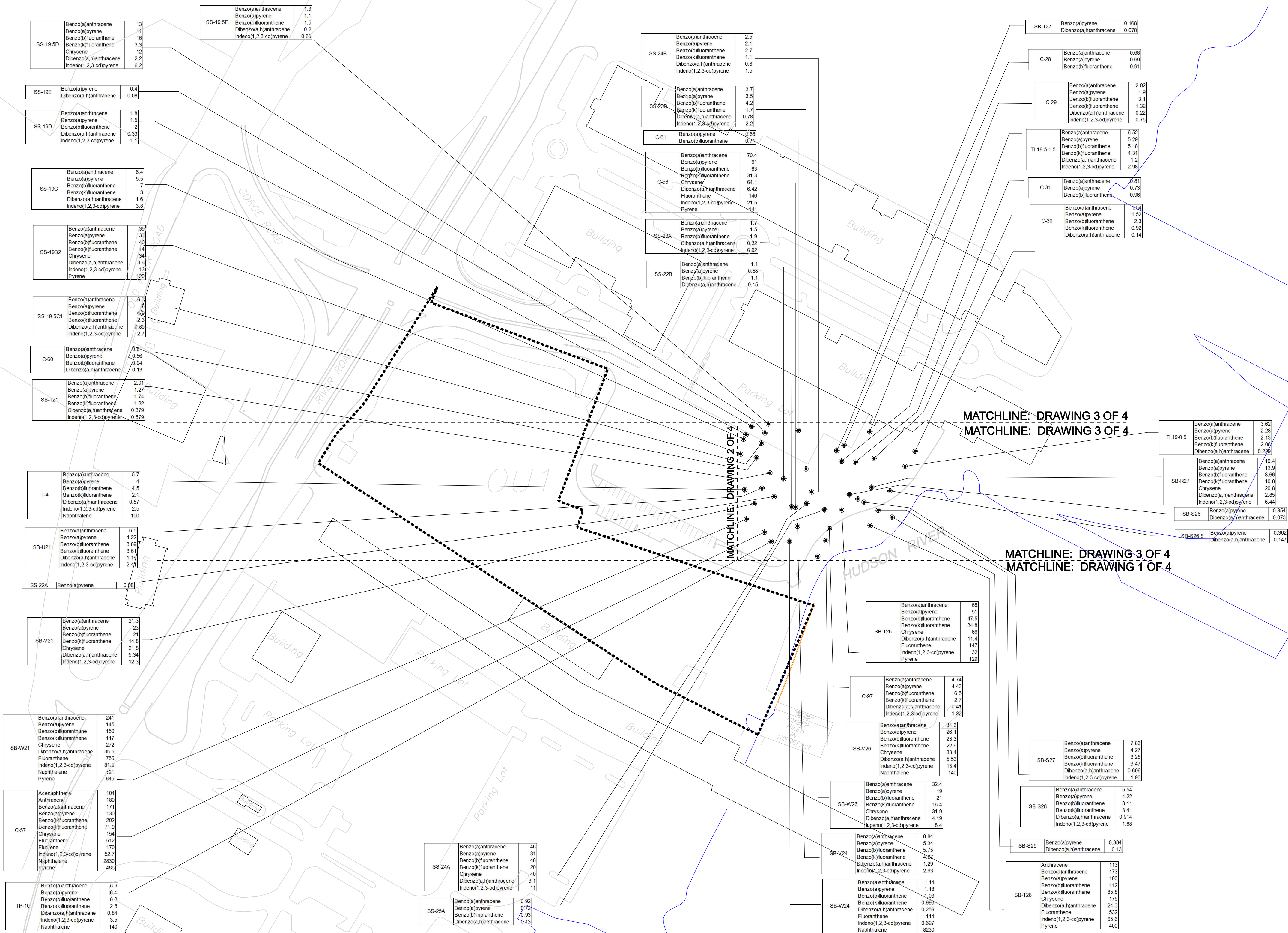


Constituents Exceeding Criteria  
PAHs in Soil > 4 feet bgs  
(sheet 3 of 4)

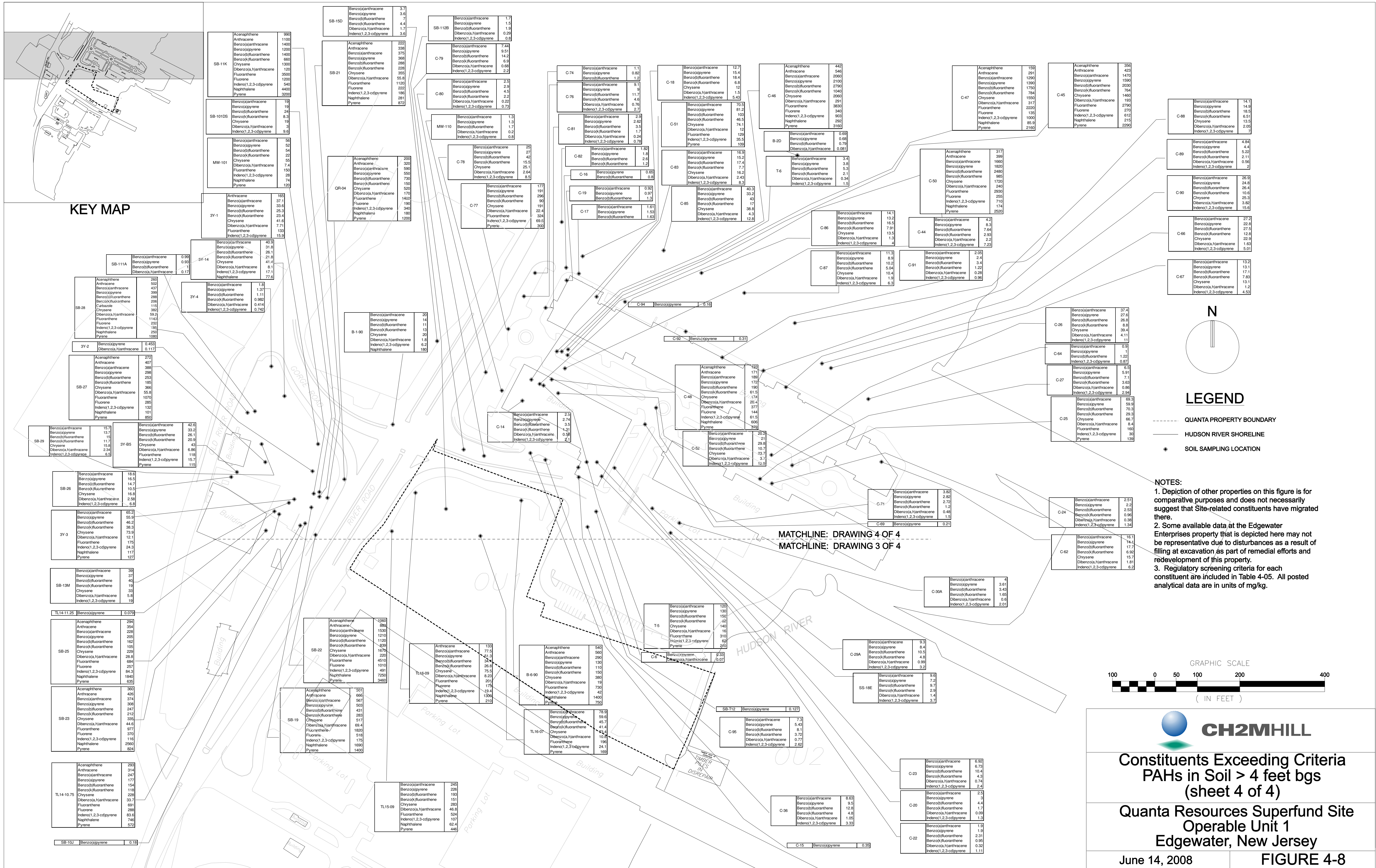
Quanta Resources Superfund Site  
Operable Unit 1  
Edgewater, New Jersey

November 9, 2007

FIGURE 4-8









**Figure 4-9 is Superseded by Figure 4-2 of the Final SRI Report**

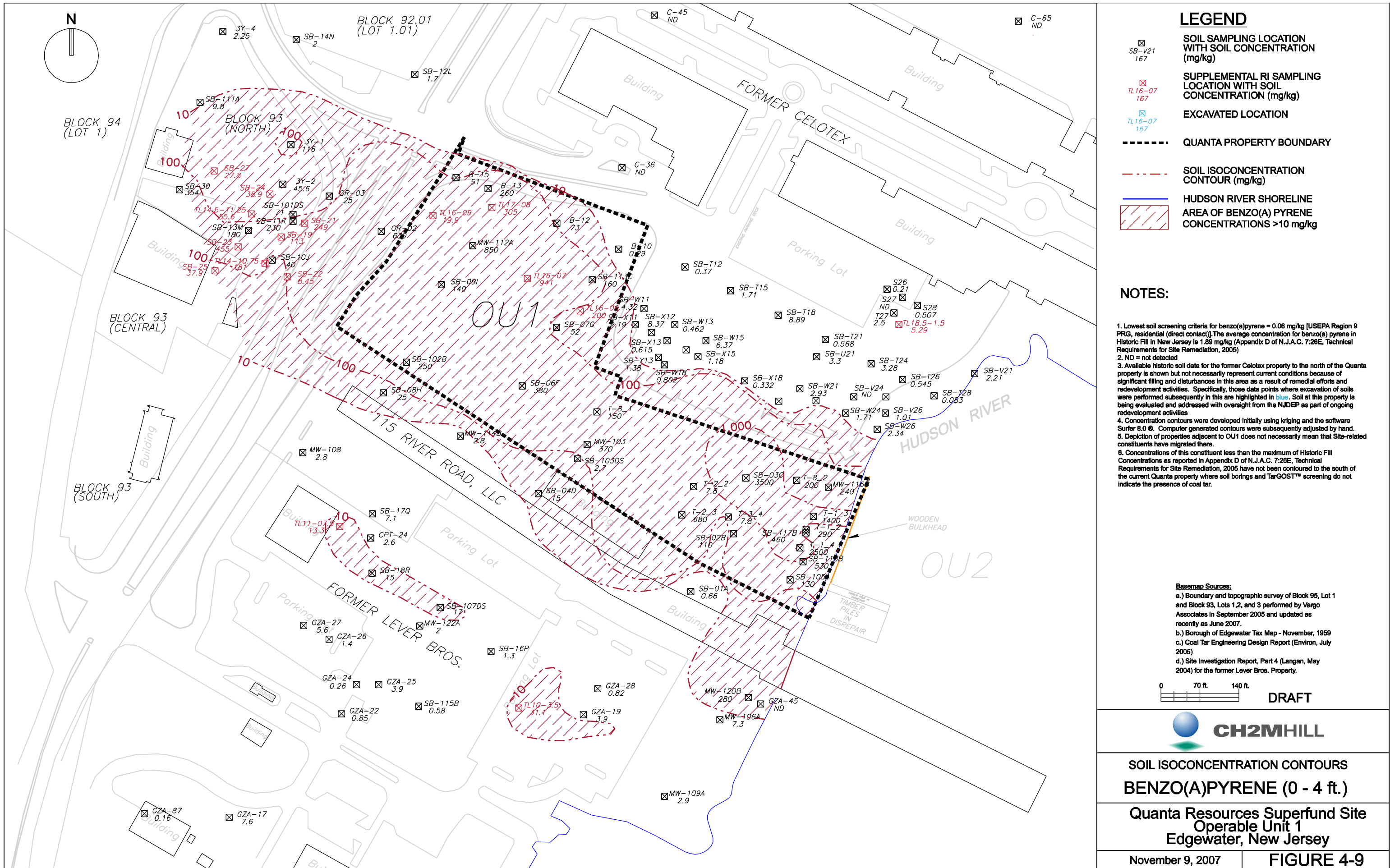
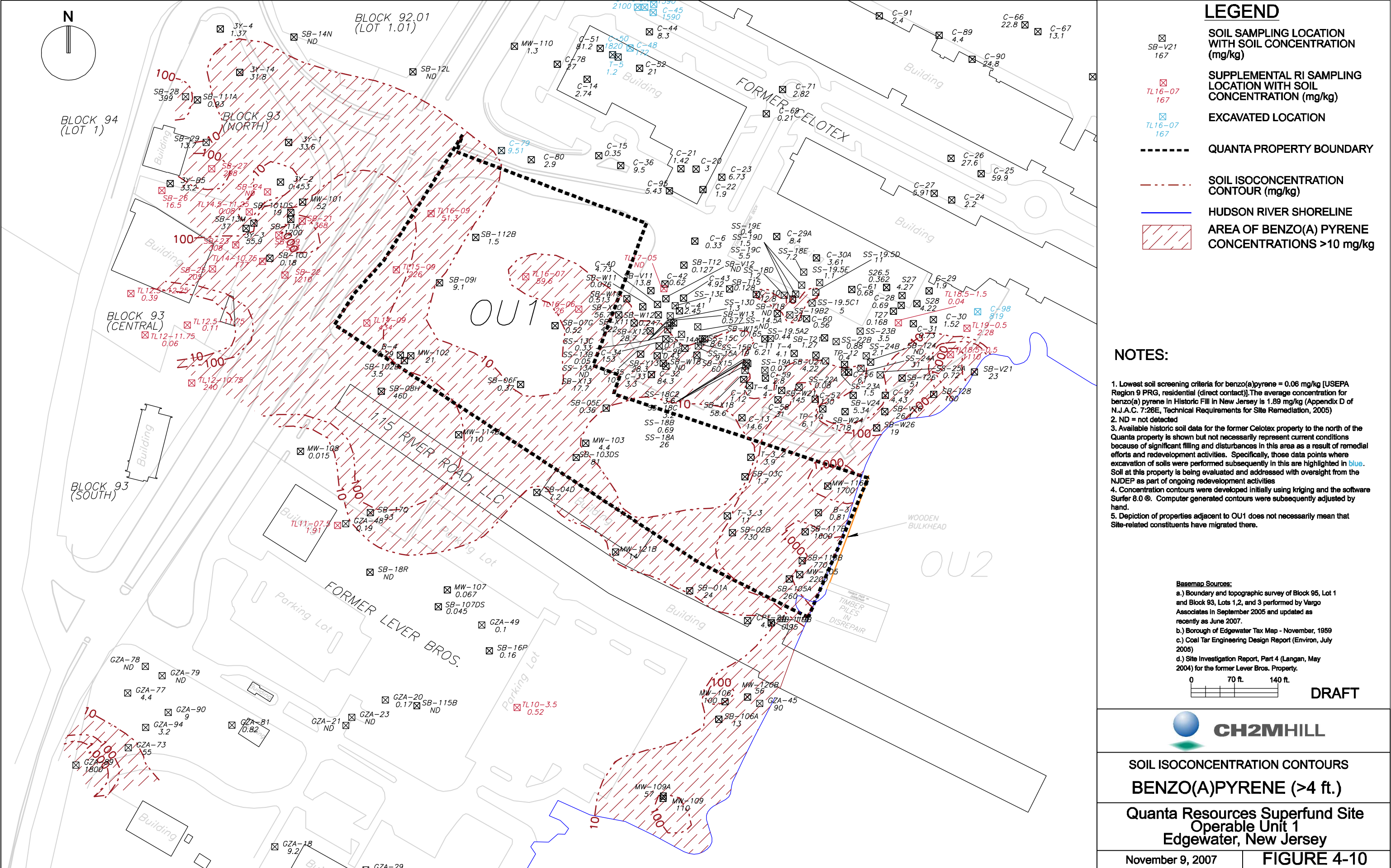
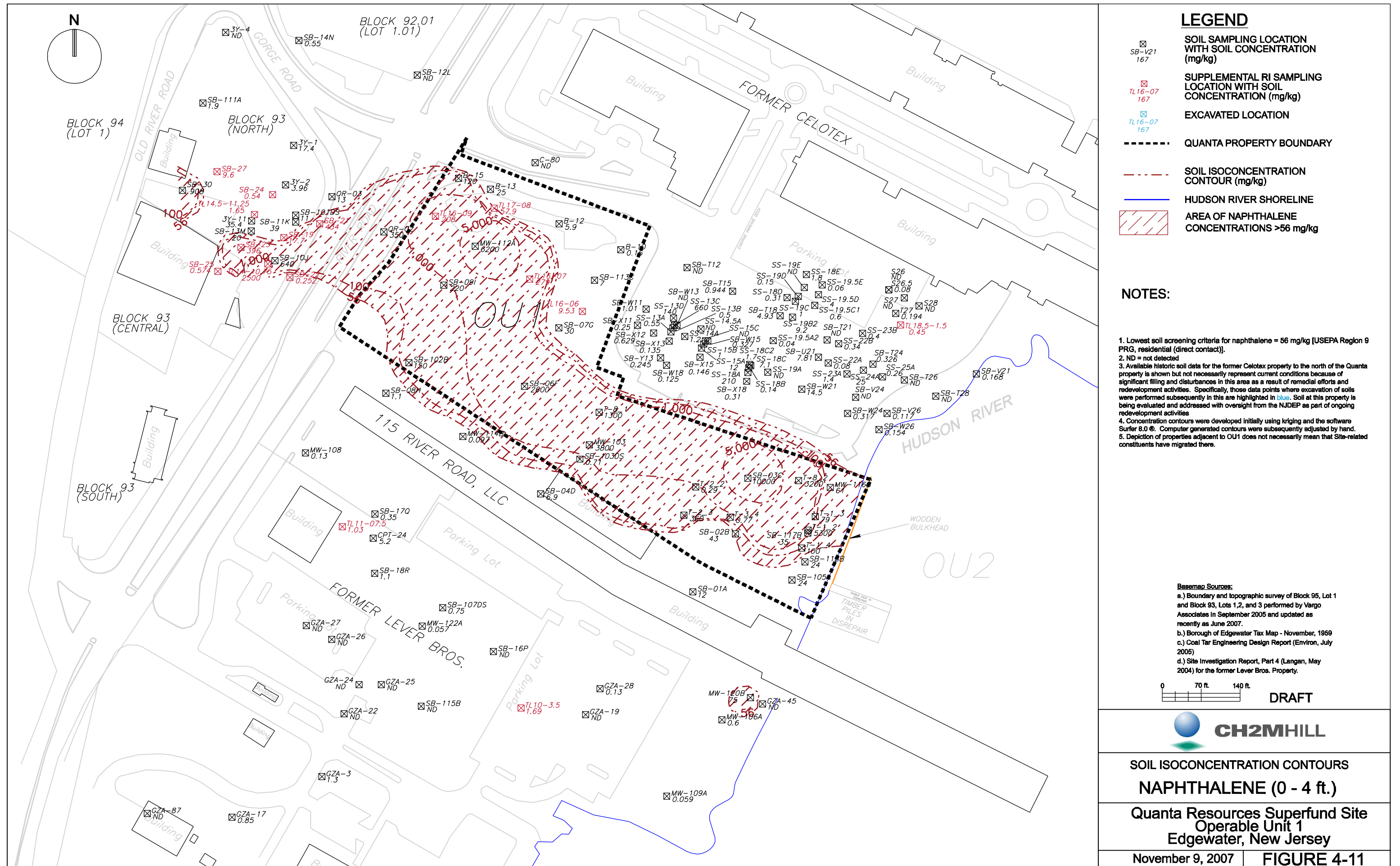


Figure 4-10 is Superseded by Figure 4-3 of the Final SRI Report



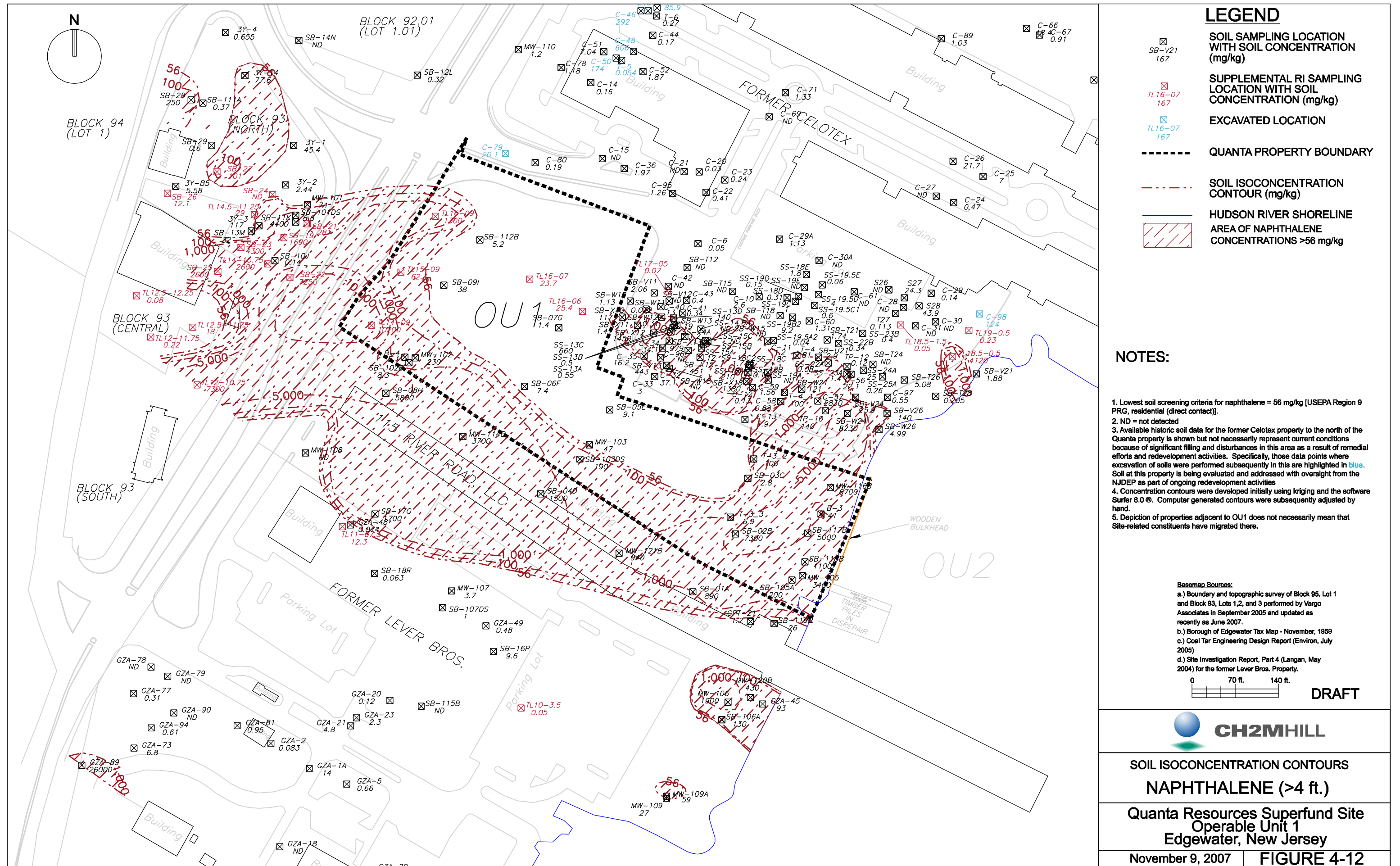


**Figure 4-11 is Superseded by Figure 4-6 of the Final SRI Report**

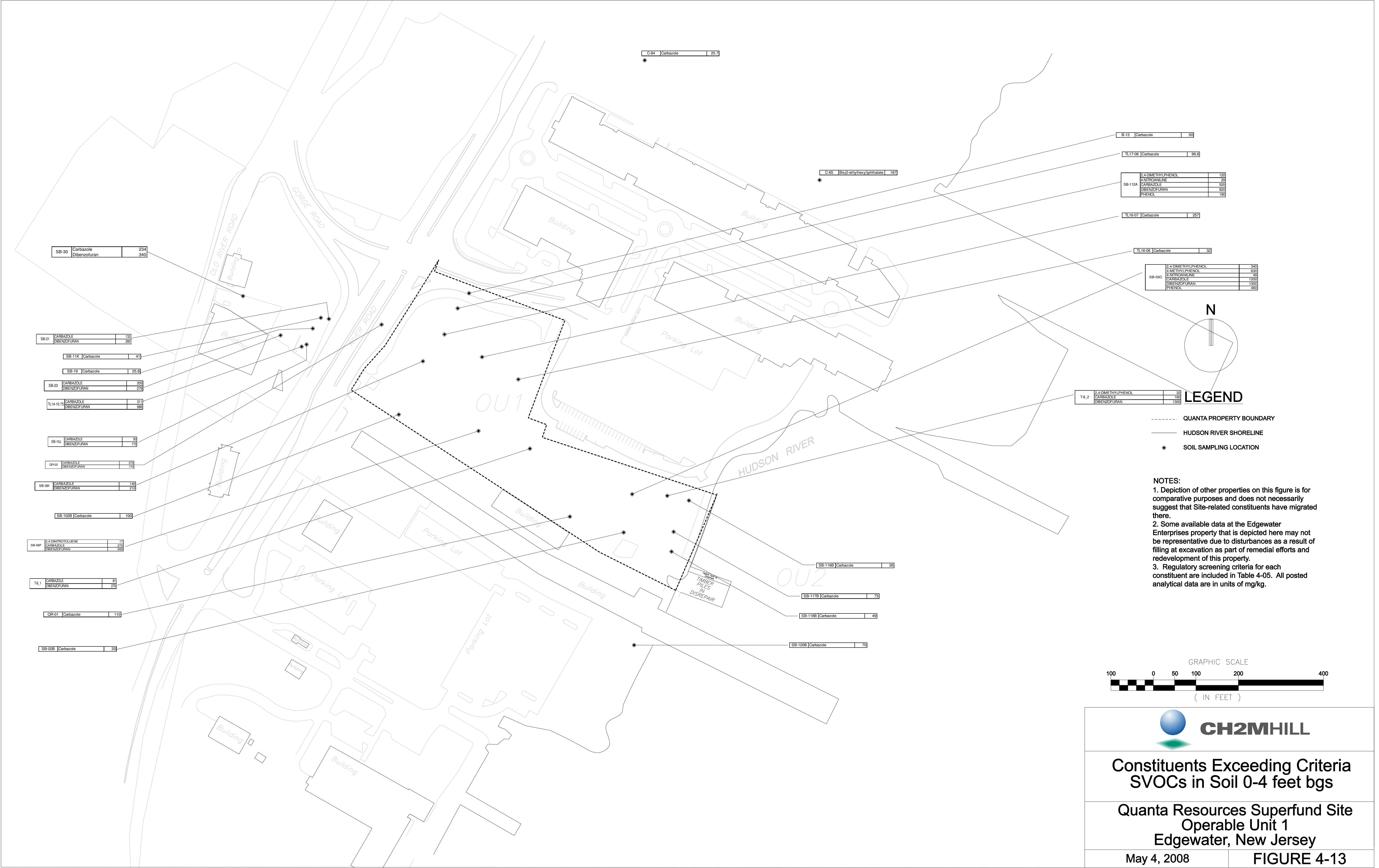




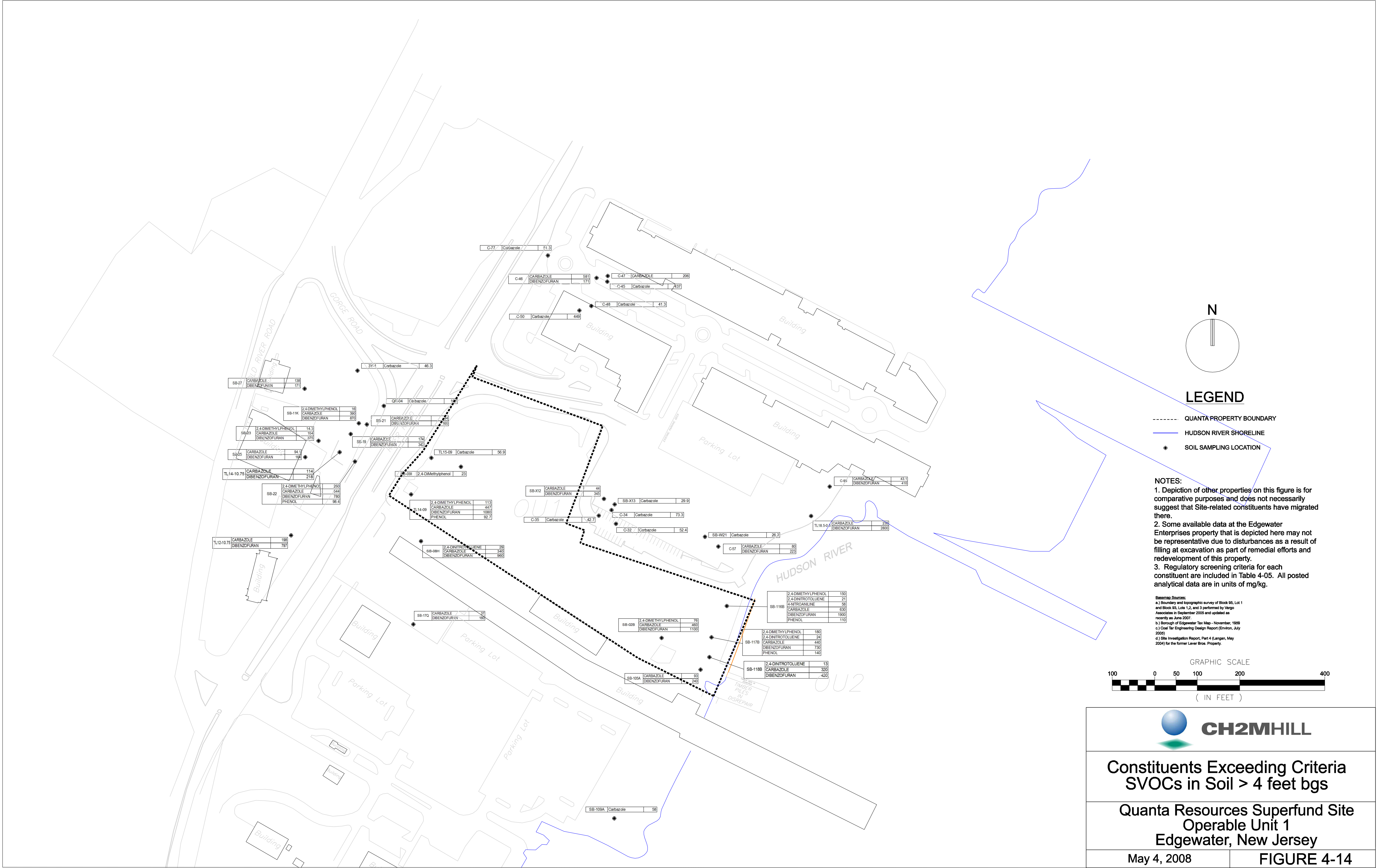
**Figure 4-12 is Superseded by Figure 4-7 of the Final SRI Report**













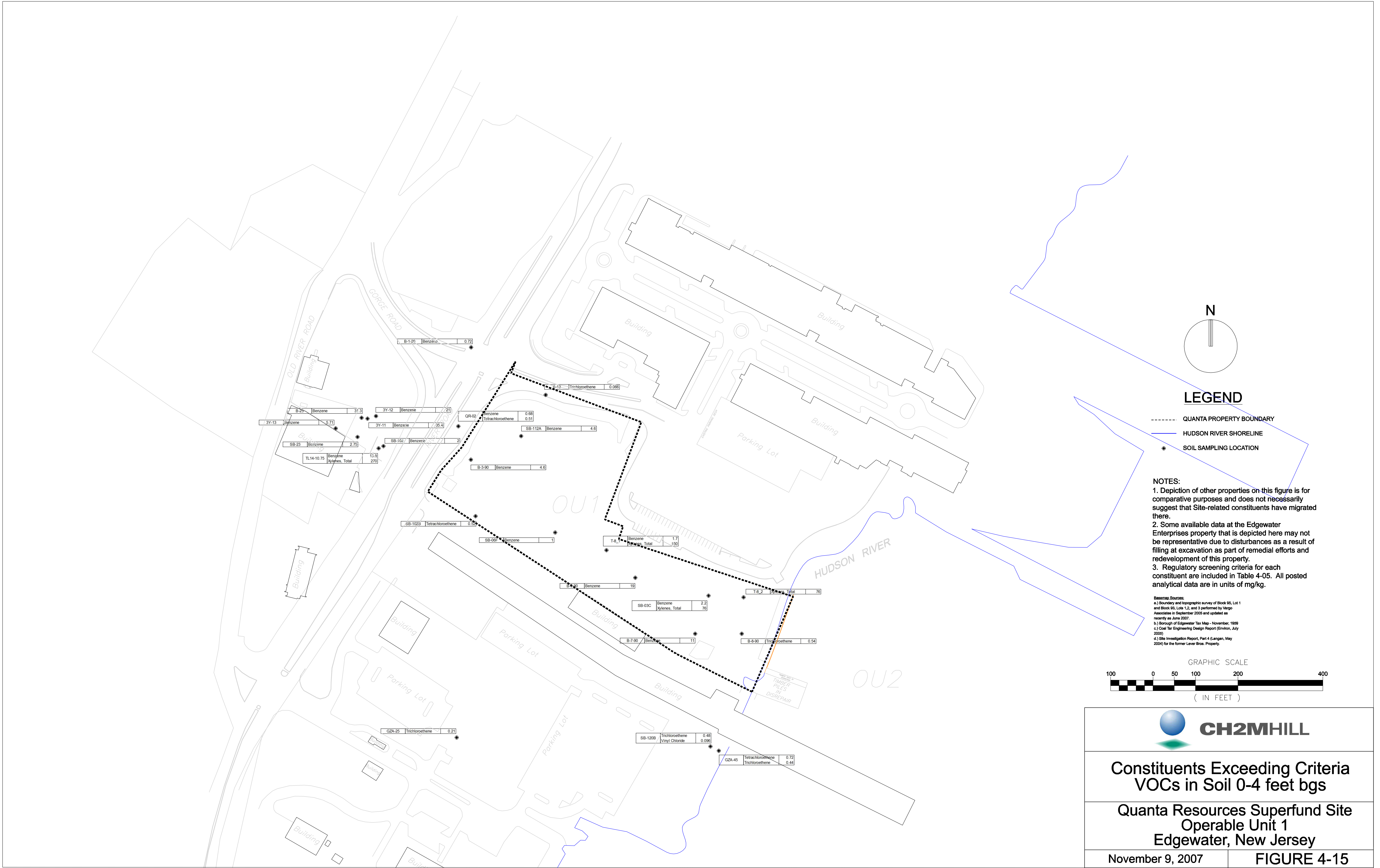








Figure 4-17 is Superseded by Figure 4-4 of the Final SRI Report

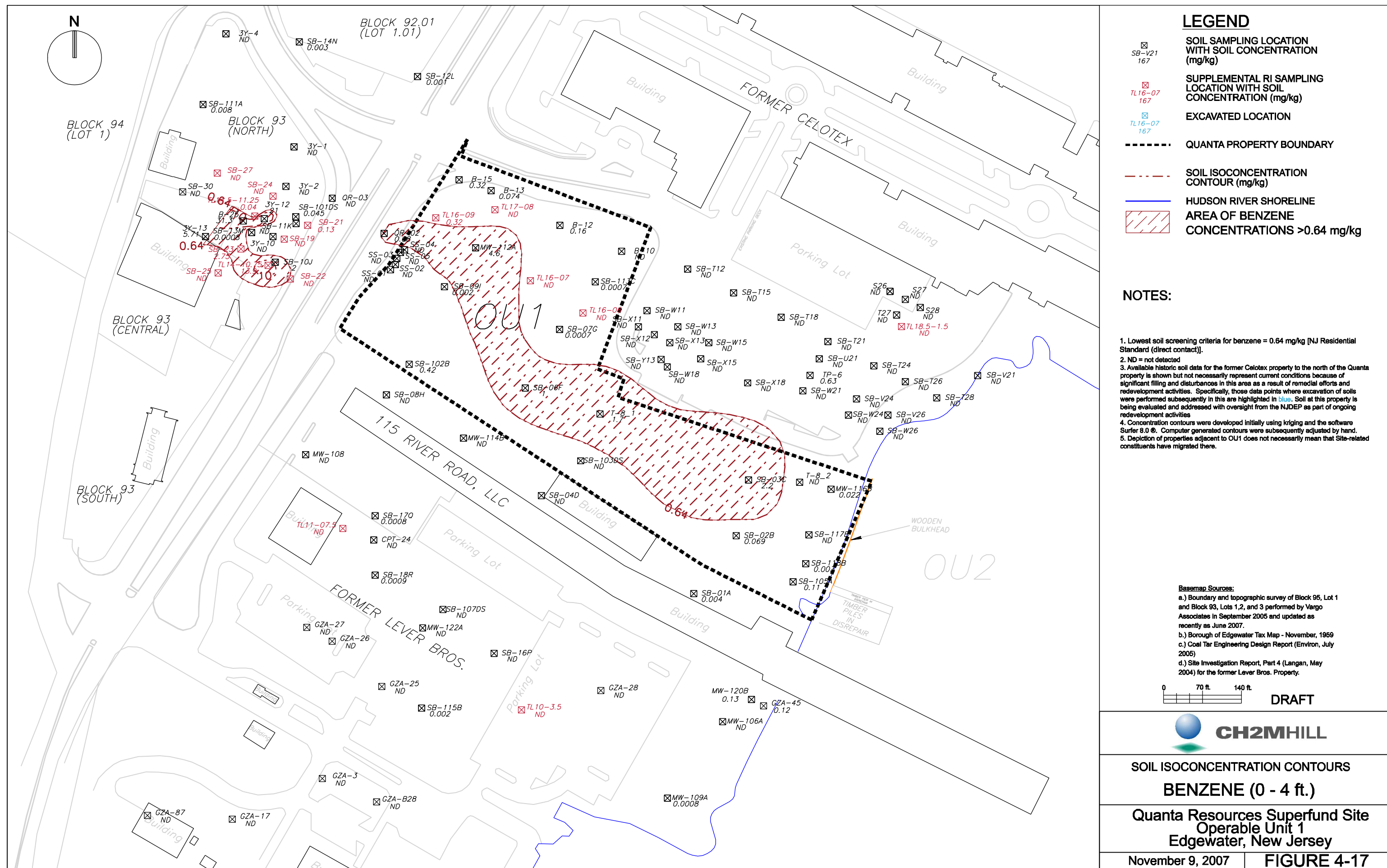
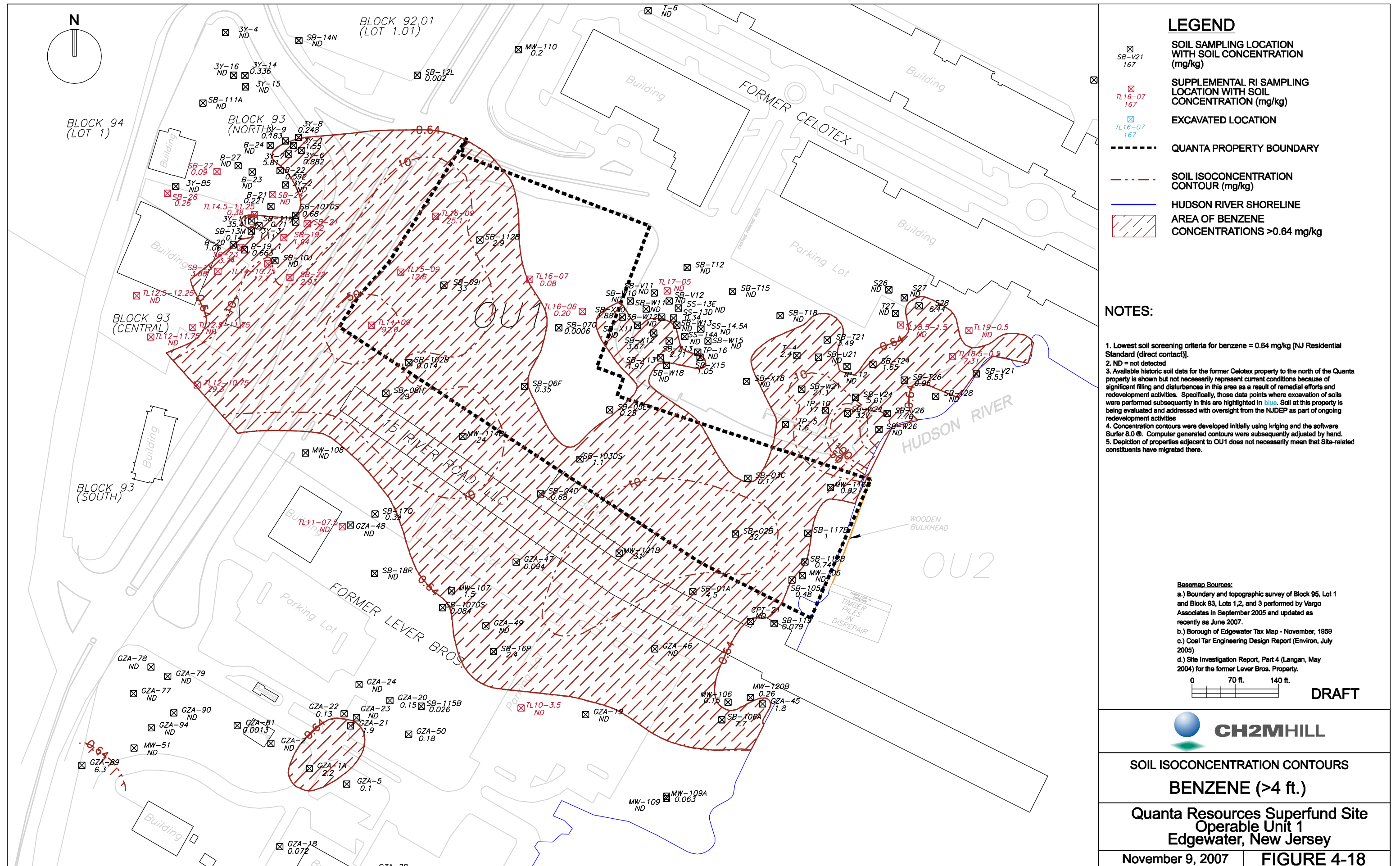
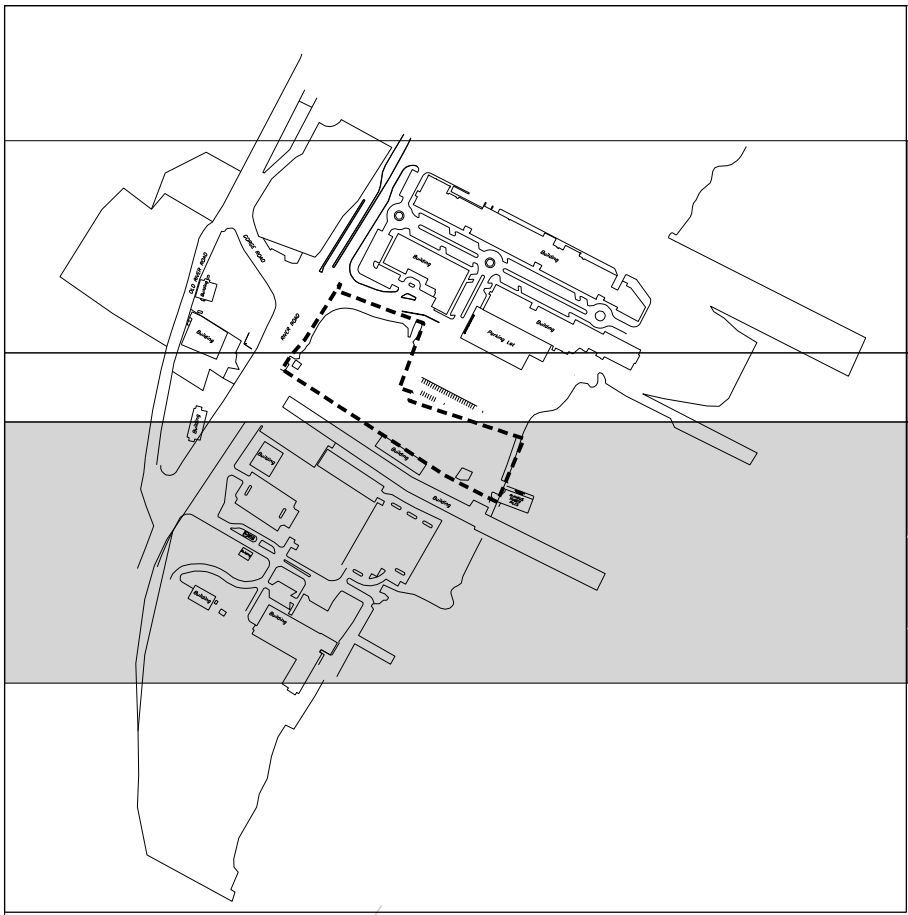


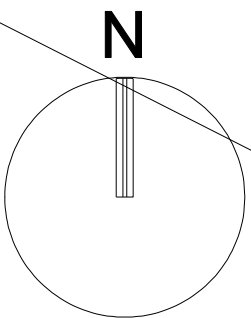
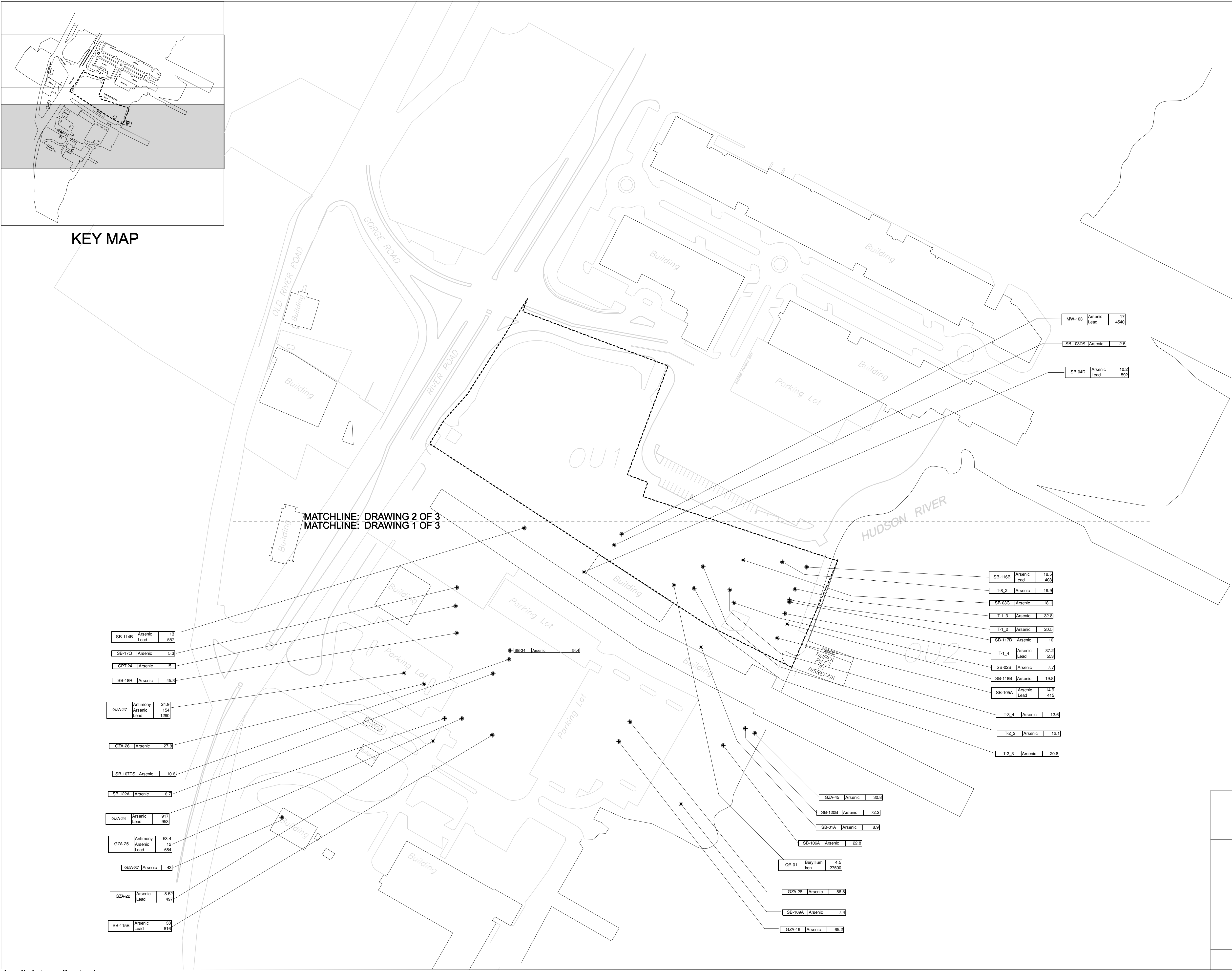
Figure 4-18 is Superseded by Figure 4-5 of the Final SRI Report







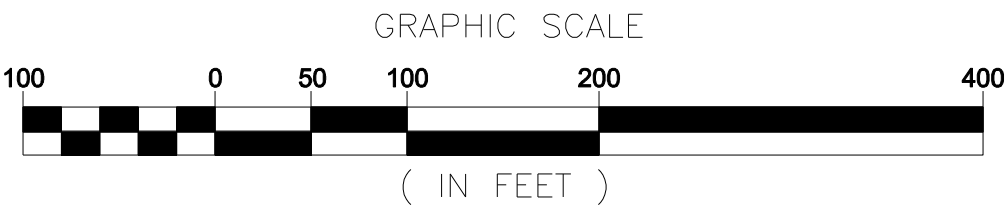
KEY MAP



LEGEND

- QUANTA PROPERTY BOUNDARY
- HUDSON RIVER SHORELINE
- SOIL SAMPLING LOCATION

NOTES:  
1. Depiction of other properties on this figure is for comparative purposes and does not necessarily suggest that Site-related constituents have migrated there.  
2. Some available data at the Edgewater Enterprises property that is depicted here may not be representative due to disturbances as a result of filling at excavation as part of remedial efforts and redevelopment of this property.  
3. Regulatory screening criteria for each constituent are included in Table 4-05. All posted analytical data are in units of mg/kg.



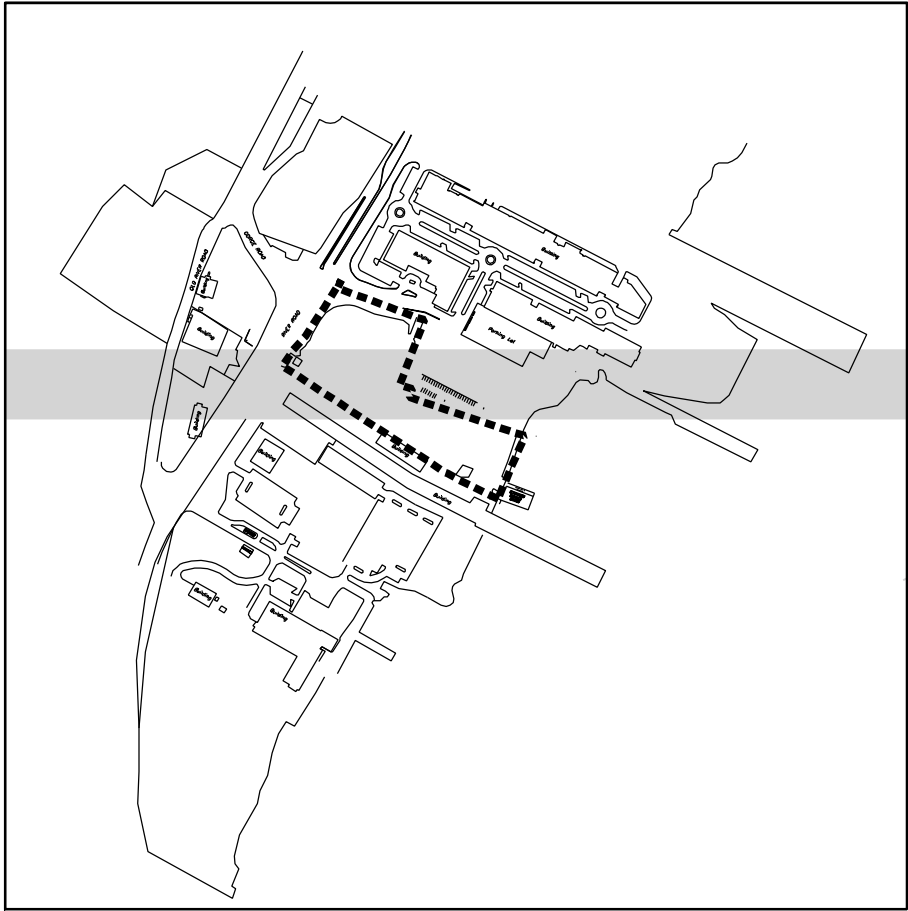
Constituents Exceeding Criteria  
Inorganics in Soil 0-4 feet bgs  
(sheet 1 of 3)

Quanta Resources Superfund Site  
Operable Unit 1  
Edgewater, New Jersey

November 9, 2007

FIGURE 4-19





KEY MAP

SB-X11	Arsenic	24.3
--------	---------	------

TL16-06	Arsenic	83.9
	Iron	62700
	Lead	751
	Vanadium	82.2

SB-091	Arsenic	51.9
	Lead	769

SB-076	Arsenic	4.7
--------	---------	-----

SB-102B	Arsenic	13.8
---------	---------	------

SB-084	Arsenic	11.9
	Lead	443

SB-06F	Arsenic	32.9
--------	---------	------

SB-X12	Arsenic	32.6
--------	---------	------

SB-X13	Arsenic	6.24
	Iron	24900

C-96	Arsenic	210
	Thallium	8.5

T-8_1	Arsenic	14.2
-------	---------	------

SB-X15	Arsenic	27
--------	---------	----

SB-X18	Arsenic	17.6
	Iron	38100

SB-W11	Arsenic	23.8
	Iron	34300
	Lead	951

SB-W13	Arsenic	7.44
	Iron	25200

SB-W15	Arsenic	54.2
--------	---------	------

SB-T15	Arsenic	9.08
--------	---------	------

SB-W18	Arsenic	11
--------	---------	----

C-81	Arsenic	10.6
------	---------	------

SB-T18	Arsenic	9.39
--------	---------	------

C-29	Lead	418
------	------	-----

SB-T27	Arsenic	7.73
--------	---------	------

C-88	Arsenic	35.9
	Lead	408

SB-T21	Arsenic	3.39
--------	---------	------

SB-U21	Arsenic	36.1
--------	---------	------

SB-R27	Arsenic	5.68
--------	---------	------

SB-S26	Arsenic	1.82
--------	---------	------

SB-S26.3	Arsenic	6.04
----------	---------	------

SB-S27	Arsenic	3.32
--------	---------	------

SB-S28	Arsenic	5.97
--------	---------	------

SB-T28	Arsenic	3.87
--------	---------	------

SB-T26	Arsenic	26.8
--------	---------	------

SB-T24	Arsenic	24.3
--------	---------	------

C-97	Arsenic	6.2
------	---------	-----

SB-V26	Arsenic	5.95
--------	---------	------

SB-V24	Arsenic	6.72
--------	---------	------

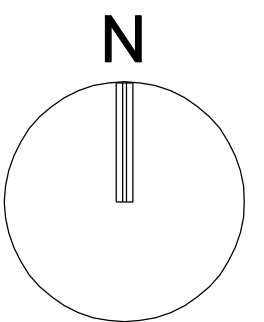
SB-V21	Arsenic	10.6
--------	---------	------

SB-W26	Arsenic	14.4
--------	---------	------

SB-W24	Arsenic	6.73
--------	---------	------

SB-W21	Arsenic	16.8
--------	---------	------

C-58	Arsenic	8.7
------	---------	-----

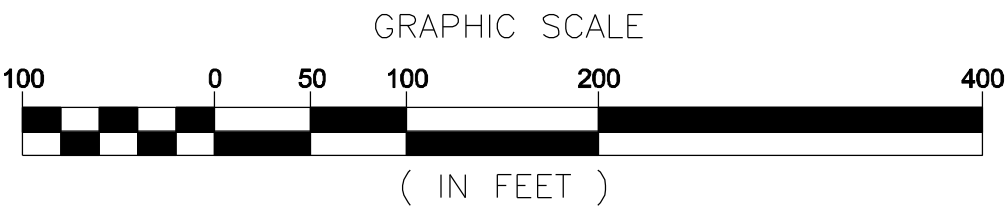


LEGEND

- QUANTA PROPERTY BOUNDARY
- HUDSON RIVER SHORELINE
- SOIL SAMPLING LOCATION

- NOTES:
1. Depiction of other properties on this figure is for comparative purposes and does not necessarily suggest that Site-related constituents have migrated there.
  2. Some available data at the Edgewater Enterprises property that is depicted here may not be representative due to disturbances as a result of filling at excavation as part of remedial efforts and redevelopment of this property.
  3. Regulatory screening criteria for each constituent are included in Table 4-05. All posted analytical data are in units of mg/kg.

Basemap Sources:  
a.) Boundary and topographic survey of Block 95, Lot 1 and Block 95, Lots 1, 2, and 3 performed by Margo Associates in September 2005 and updated as recently as June 2007.  
b.) Borough of Edgewater Tax Map - November, 1999  
c.) Coal Tar Engineering Design Report (Environ, July 2005)  
d.) Site Investigation Report, Part 4 (Langen, May 2004) for the former Lever Bros. Property.



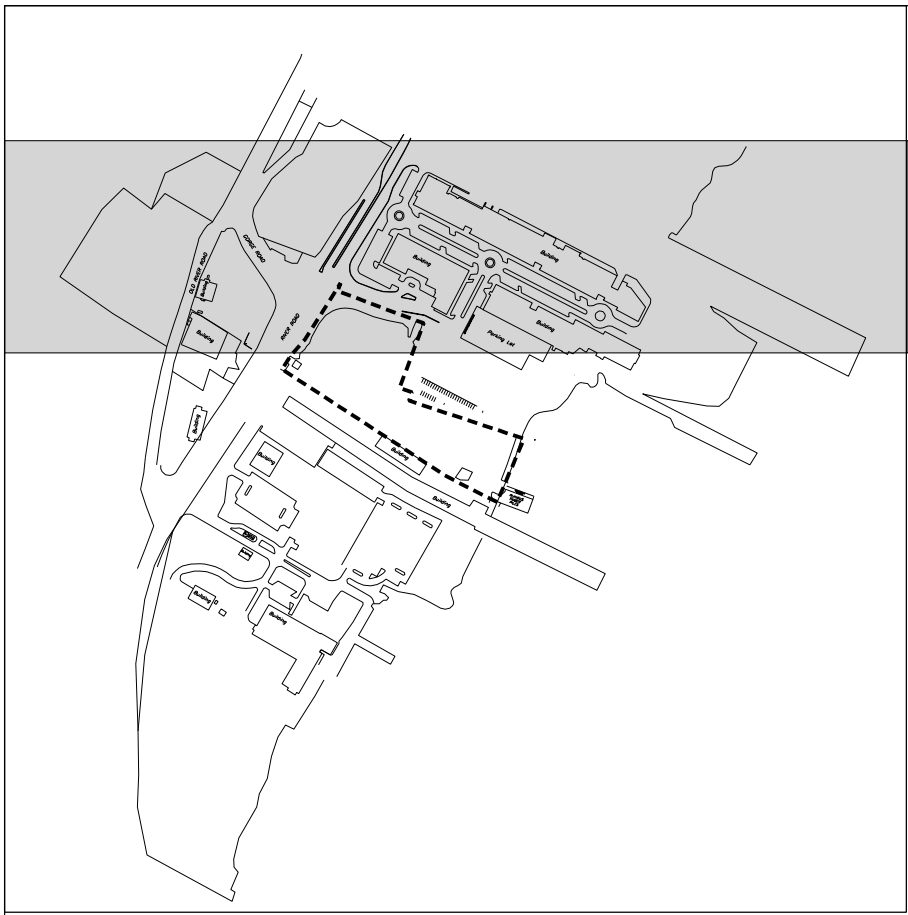
Constituents Exceeding Criteria  
Inorganics in Soil 0-4 feet bgs  
(sheet 2 of 3)

Quanta Resources Superfund Site  
Operable Unit 1  
Edgewater, New Jersey

November 9, 2007

FIGURE 4-19





KEY MAP

B-13	Antimony	29.3
	Arsenic	370
	Iron	54100
	Lead	1540
Thallium	8.3	

SB-14N	Arsenic	5.3
--------	---------	-----

3Y-4	Arsenic	6.43
------	---------	------

B-14	Arsenic	628
------	---------	-----

B-15	Antimony	23
	Arsenic	338
	Iron	81500
	Lead	1850
	Mercury	15.4
Thallium		4.3

B-16	Arsenic	1650
------	---------	------

SB-111A	Arsenic	17.4
---------	---------	------

SB-28	Arsenic	989
-------	---------	-----

3Y-1	Arsenic	18.3
	Beryllium	3.45
	Iron	32400

TL16-09	Antimony	174
	Arsenic	1940
	Copper	6170
	Iron	257000
	Lead	7730
	Zinc	3820

SB-30	Arsenic	16.2
-------	---------	------

QR-03	Iron	3690
	Vanadium	95.3

3Y-2	Arsenic	34.3
	Iron	50900
	Lead	514

TL15-10.75	Arsenic	32.1
------------	---------	------

SB-24	Arsenic	37.6
-------	---------	------

SB-101DS	Arsenic	19.9
----------	---------	------

SB-29	Arsenic	322
	Copper	657
	Iron	5880
	Lead	1650

AD-SS-10	Arsenic	19.3
----------	---------	------

AD-SS-12	Arsenic	1380
----------	---------	------

AD-SS-11	Arsenic	313
----------	---------	-----

SB-11K	Arsenic	14
	Beryllium	4.4
	Iron	30600

SB-13M	Antimony	24.1
	Arsenic	913
	Iron	38300
	Lead	636
	Thallium	4.8

SB-31	Arsenic	162
-------	---------	-----

SB-23	Arsenic	27.1
-------	---------	------

SB-19	Antimony	15.7
	Arsenic	116
	Lead	1960

TL14-10.75	Arsenic	111
	Iron	25300
	Lead	731

SB-10J	Arsenic	22.3
--------	---------	------

SB-21	Arsenic	17.9
-------	---------	------

SB-22	Antimony	41
	Arsenic	220
	Iron	31900
	Lead	750

QR-02	Iron	26100
-------	------	-------

SB-38	Antimony	229
	Arsenic	915
	Barium	1040
	Copper	3470
	Iron	294000
	Lead	8640

SB-31	Arsenic	162
-------	---------	-----

SB-23	Arsenic	27.1
-------	---------	------

SB-19	Arsenic	15.7
-------	---------	------

TL14-10.75	Arsenic	111
------------	---------	-----

SB-10J	Arsenic	22.3
--------	---------	------

SB-21	Arsenic	17.9
-------	---------	------

SB-22	Arsenic	41
-------	---------	----

QR-02	Iron	26100
-------	------	-------

SB-38	Antimony	229
	Arsenic	915
	Barium	1040
	Copper	3470
	Iron	294000
	Lead	8640

SB-31	Arsenic	162
-------	---------	-----

SB-23	Arsenic	27.1
-------	---------	------

SB-19	Arsenic	15.7
-------	---------	------

TL14-10.75	Arsenic	111
------------	---------	-----

SB-10J	Arsenic	22.3
--------	---------	------

SB-21	Arsenic	17.9
-------	---------	------

SB-22	Arsenic	41
-------	---------	----

QR-02	Iron	26100
-------	------	-------

SB-38	Antimony	229
	Arsenic	915
	Barium	1040
	Copper	3470
	Iron	294000
	Lead	8640

SB-31	Arsenic	162
-------	---------	-----

SB-23	Arsenic	27.1
-------	---------	------

SB-19	Arsenic	15.7
-------	---------	------

TL14-10.75	Arsenic	111
------------	---------	-----

SB-10J	Arsenic	22.3
--------	---------	------

SB-21	Arsenic	17.9
-------	---------	------

SB-22	Arsenic	41
-------	---------	----

QR-02	Iron	26100
-------	------	-------

SB-38	Antimony	229
	Arsenic	915
	Barium	1040
	Copper	3470
	Iron	294000
	Lead	8640

SB-31	Arsenic	162
-------	---------	-----

SB-23	Arsenic	27.1
-------	---------	------

SB-19	Arsenic	15.7
-------	---------	------

TL14-10.75	Arsenic	111
------------	---------	-----

SB-10J	Arsenic	22.3
--------	---------	------

SB-21	Arsenic	17.9
-------	---------	------

SB-22	Arsenic	41
-------	---------	----

QR-02	Iron	26100
-------	------	-------

SB-38	Antimony	229
	Arsenic	915
	Barium	1040
	Copper	3470
	Iron	294000
	Lead	8640

SB-31	Arsenic	162
-------	---------	-----

SB-23	Arsenic	27.1
-------	---------	------

SB-19	Arsenic	15.7
-------	---------	------

TL14-10.75	Arsenic	111
------------	---------	-----

SB-10J	Arsenic	22.3
--------	---------	------

SB-21	Arsenic	17.9
-------	---------	------

SB-22	Arsenic	41
-------	---------	----

QR-02	Iron	26100
-------	------	-------

SB-38	Antimony	229
	Arsenic	915
	Barium	1040
	Copper	3470
	Iron	294000
	Lead	8640

SB-31	Arsenic	162
-------	---------	-----

SB-23	Arsenic	27.1
-------	---------	------

SB-19	Arsenic	15.7
-------	---------	------

TL14-10.75	Arsenic	111
------------	---------	-----

SB-10J	Arsenic	22.3
--------	---------	------

SB-21	Arsenic	17.9
-------	---------	------

SB-22	Arsenic	41
-------	---------	----

QR-02	Iron	26100
-------	------	-------

SB-38	Antimony	229
	Arsenic	915
	Barium	1040
	Copper	3470
	Iron	294000
	Lead	8640

SB-31	Arsenic	162
-------	---------	-----

SB-23	Arsenic	27.1
-------	---------	------

SB-19	Arsenic	15.7
-------	---------	------

TL14-10.75	Arsenic	111
------------	---------	-----

SB-10J	Arsenic	22.3
--------	---------	------

SB-21	Arsenic	17.9
-------	---------	------

SB-22	Arsenic	41
-------	---------	----

QR-02	Iron	26100
-------	------	-------

SB-38	Antimony	229
	Arsenic	915
	Barium	1040
	Copper	3470
	Iron	294000
	Lead	8640

SB-31	Arsenic	162
-------	---------	-----

SB-23	Arsenic	27.1
-------	---------	------

SB-19	Arsenic	15.7
-------	---------	------

TL14-10.75	Arsenic	111
------------	---------	-----

SB-10J	Arsenic	22.3
--------	---------	------

SB-21	Arsenic	17.9
-------	---------	------

SB-22	Arsenic	41
-------	---------	----

QR-02	Iron	26100
-------	------	-------

SB-38	Antimony	229
	Arsenic	915
	Barium	1040
	Copper	3470
	Iron	294000
	Lead	8640

SB-31	Arsenic	162
-------	---------	-----

SB-23	Arsenic	27.1
-------	---------	------

SB-19	Arsenic	15.7
-------	---------	------

TL14-10.75	Arsenic	111
------------	---------	-----

SB-10J	Arsenic	22.3
--------	---------	------

SB-21	Arsenic	17.9
-------	---------	------

SB-22	Arsenic	41
-------	---------	----

QR-02	Iron	26100
-------	------	-------

SB-38	Antimony	229
	Arsenic	915
	Barium	1040
	Copper	3470
	Iron	294000
	Lead	8640

SB-31	Arsenic	162
-------	---------	-----

SB-23	Arsenic	27.1
-------	---------	------

SB-19	Arsenic	15.7
-------	---------	------

TL14-10.75	Arsenic	111
------------	---------	-----

SB-10J	Arsenic	22.3
--------	---------	------

SB-21	Arsenic	17.9
-------	---------	------

SB-22	Arsenic	41
-------	---------	----

QR-02	Iron	26100
-------	------	-------

SB-38	Antimony	229
	Arsenic	915
	Barium	1040
	Copper	3470
	Iron	294000
	Lead	8640

SB-31	Arsenic	162
-------	---------	-----

SB-23	Arsenic	27.1
-------	---------	------

SB-19	Arsenic	15.7
-------	---------	------

TL14-10.75	Arsenic	111
------------	---------	-----

SB-10J	Arsenic	22.3
--------	---------	------

SB-21	Arsenic	17.9
-------	---------	------

SB-22	Arsenic	41
-------	---------	----

QR-02	Iron	26100
-------	------	-------

SB-38	Antimony	229
	Arsenic	915
	Barium	1040
	Copper	3470
	Iron	294000
	Lead	8640

SB-31	Arsenic	162
-------	---------	-----

SB-23	Arsenic	27.1
-------	---------	------

SB-19	Arsenic	15.7
-------	---------	------

TL14-10.75	Arsenic	111
------------	---------	-----

SB-10J	Arsenic	22.3
--------	---------	------

SB-21	Arsenic	17.9
-------	---------	------

SB-22	Arsenic	41
-------	---------	----

QR-02	Iron	26100
-------	------	-------

SB-38	Antimony	229
	Arsenic	915
	Barium	1040
	Copper	3470
	Iron	294000
	Lead	8640

SB-31	Arsenic	162
-------	---------	-----

SB-23	Arsenic	27.1
-------	---------	------

SB-19	Arsenic	15.7
-------	---------	------

TL14-10.75	Arsenic	111
------------	---------	-----

SB-10J	Arsenic	22.3
--------	---------	------

SB-21	Arsenic	17.9
-------	---------	------

SB-22	Arsenic	41
-------	---------	----

QR-02	Iron	26100
-------	------	-------

SB-38	Antimony	229
	Arsenic	915
	Barium	1040
	Copper	3470
	Iron	294000
	Lead	8640

SB-31	Arsenic	162
-------	---------	-----

SB-23	Arsenic	27.1
-------	---------	------

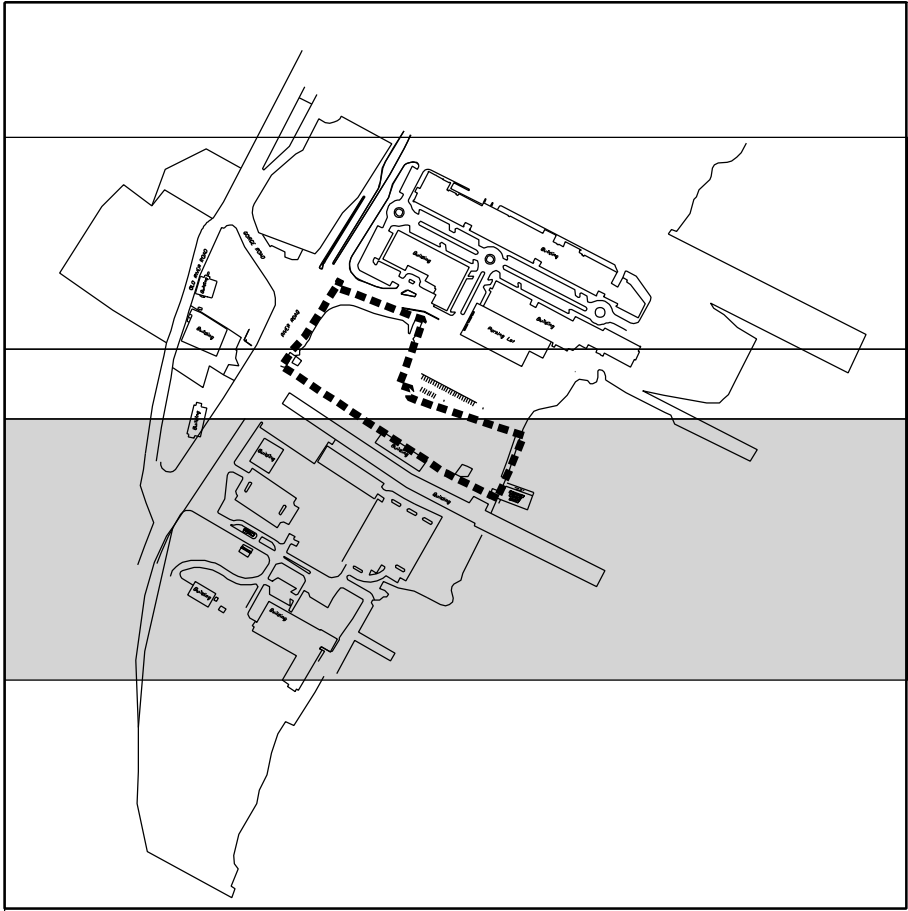
SB-19	Arsenic	15.7
-------	---------	------

TL14-10.75	Arsenic	111
------------	---------	-----

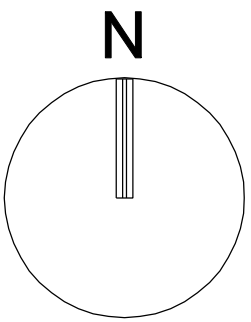
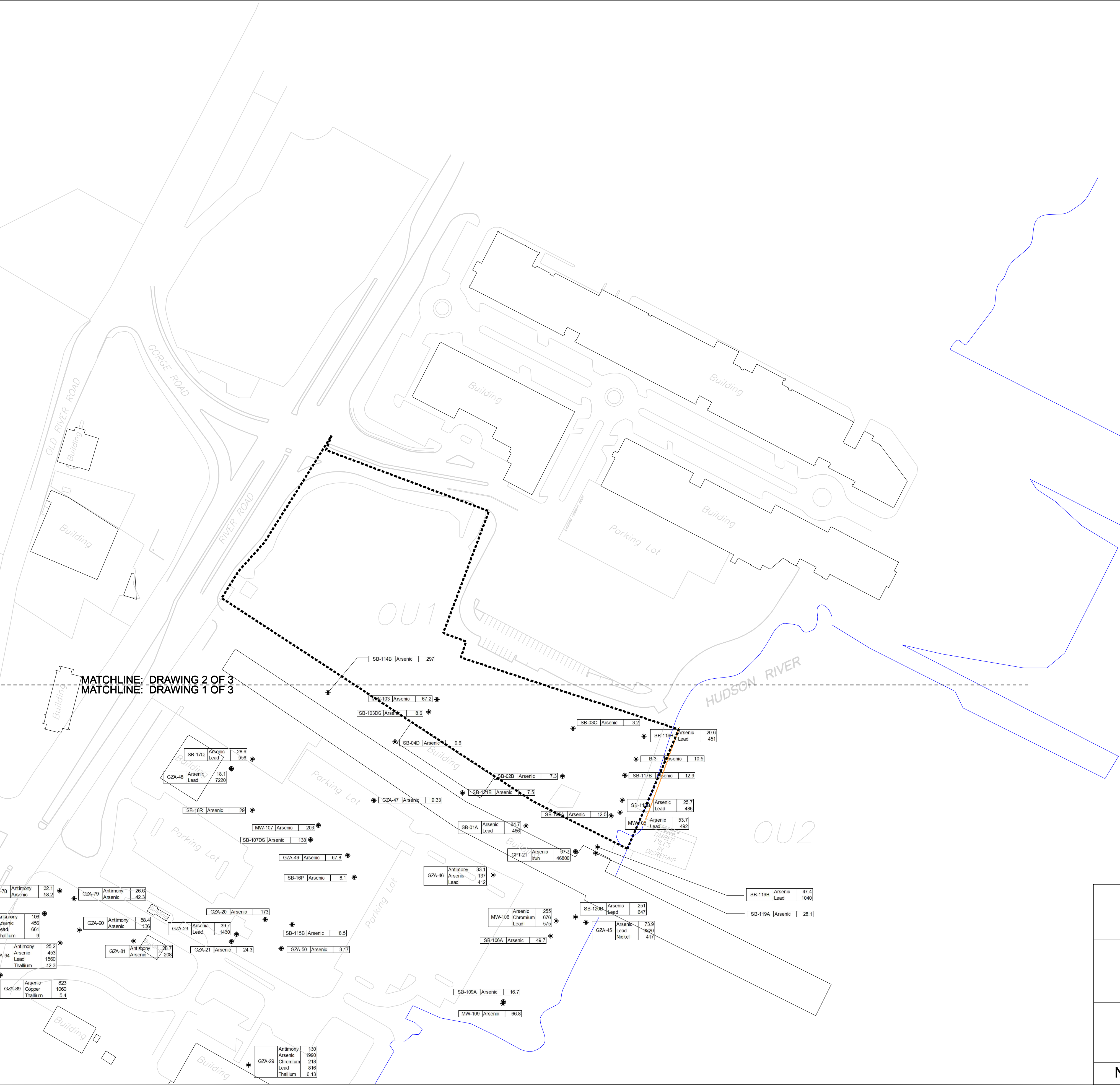
SB-10J	Arsenic	22.3
--------	---------	------

SB-21	Arsenic	17.9
-------	---------	------





KEY MAP

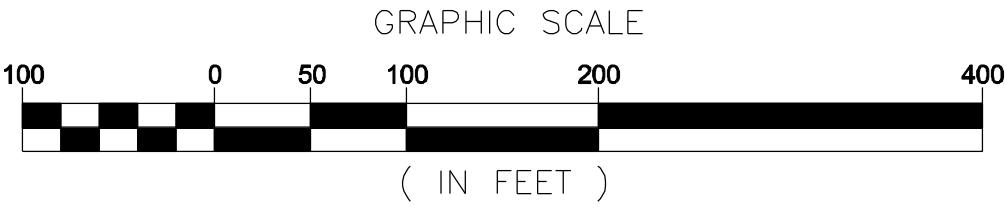


LEGEND

- QUANTA PROPERTY BOUNDARY
- HUDSON RIVER SHORELINE
- SOIL SAMPLING LOCATION

- NOTES:
1. Depiction of other properties on this figure is for comparative purposes and does not necessarily suggest that Site-related constituents have migrated there.
  2. Some available data at the Edgewater Enterprises property that is depicted here may not be representative due to disturbances as a result of filling at excavation as part of remedial efforts and redevelopment of this property.
  3. Regulatory screening criteria for each constituent are included in Table 4-05. All posted analytical data are in units of mg/kg.

Basemap Sources:  
a.) Boundary and topographic survey of Block 95, Lot 1 and Block 95, Lots 1, 2, and 3 performed by Vargo Associates in September 2005 and updated as recently as June 2007.  
b.) Borough of Edgewater Tax Map - November, 1999  
c.) Coal Tar Engineering Design Report (Environ, July 2005)  
d.) Site Investigation Report, Part 4 (Langen, May 2004) for the former Lever Bros. Property.



Constituents Exceeding Criteria  
Inorganics in Soil > 4 feet bgs  
(sheet 1 of 3)

Quanta Resources Superfund Site  
Operable Unit 1  
Edgewater, New Jersey

November 9, 2007

FIGURE 4-20







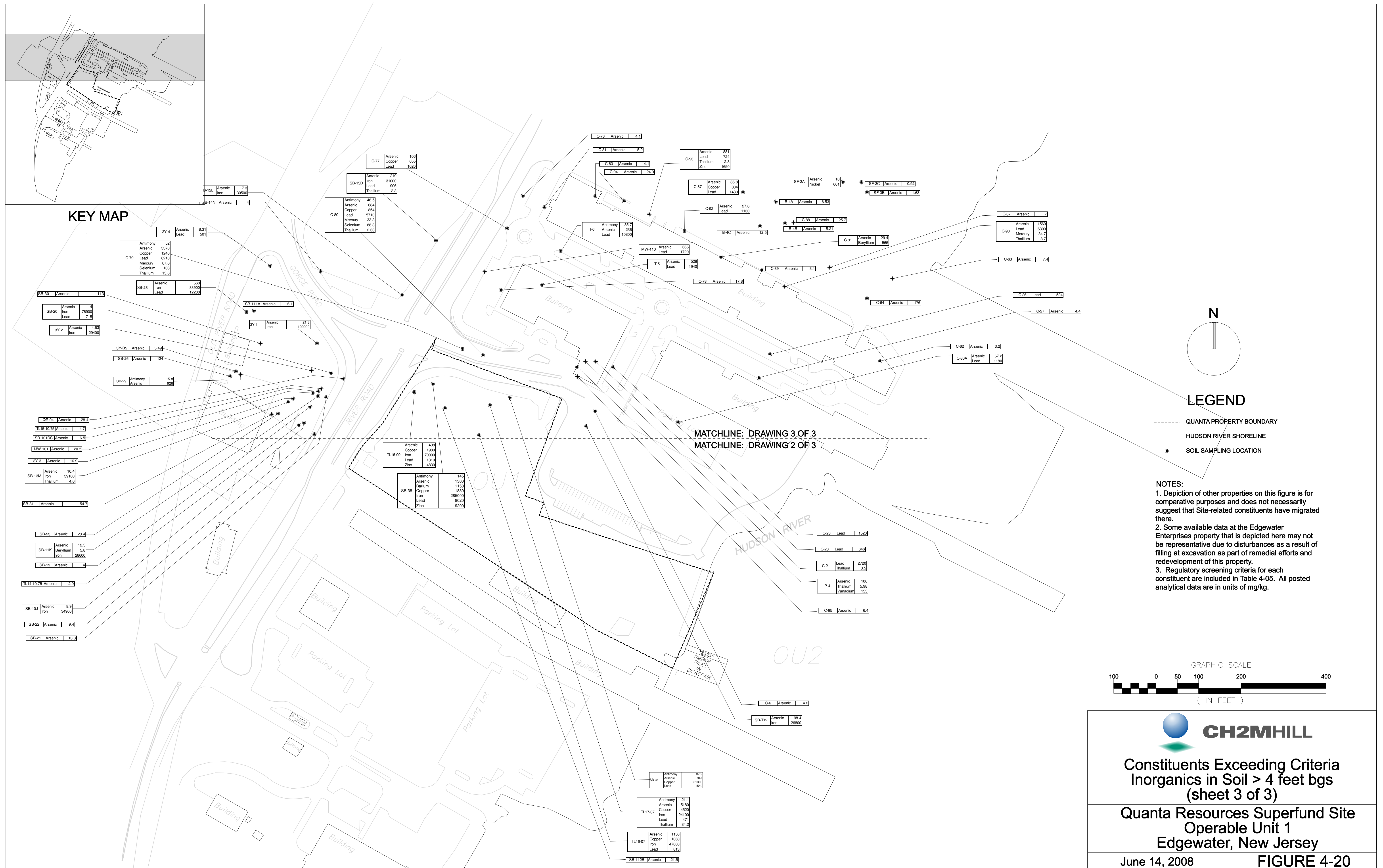




Figure 4-21 is Superseded by Figure 5-3 of the Final SRI Report



**Figure 4-22 is Superseded by Figure 5-4 of the Final SRI Report**

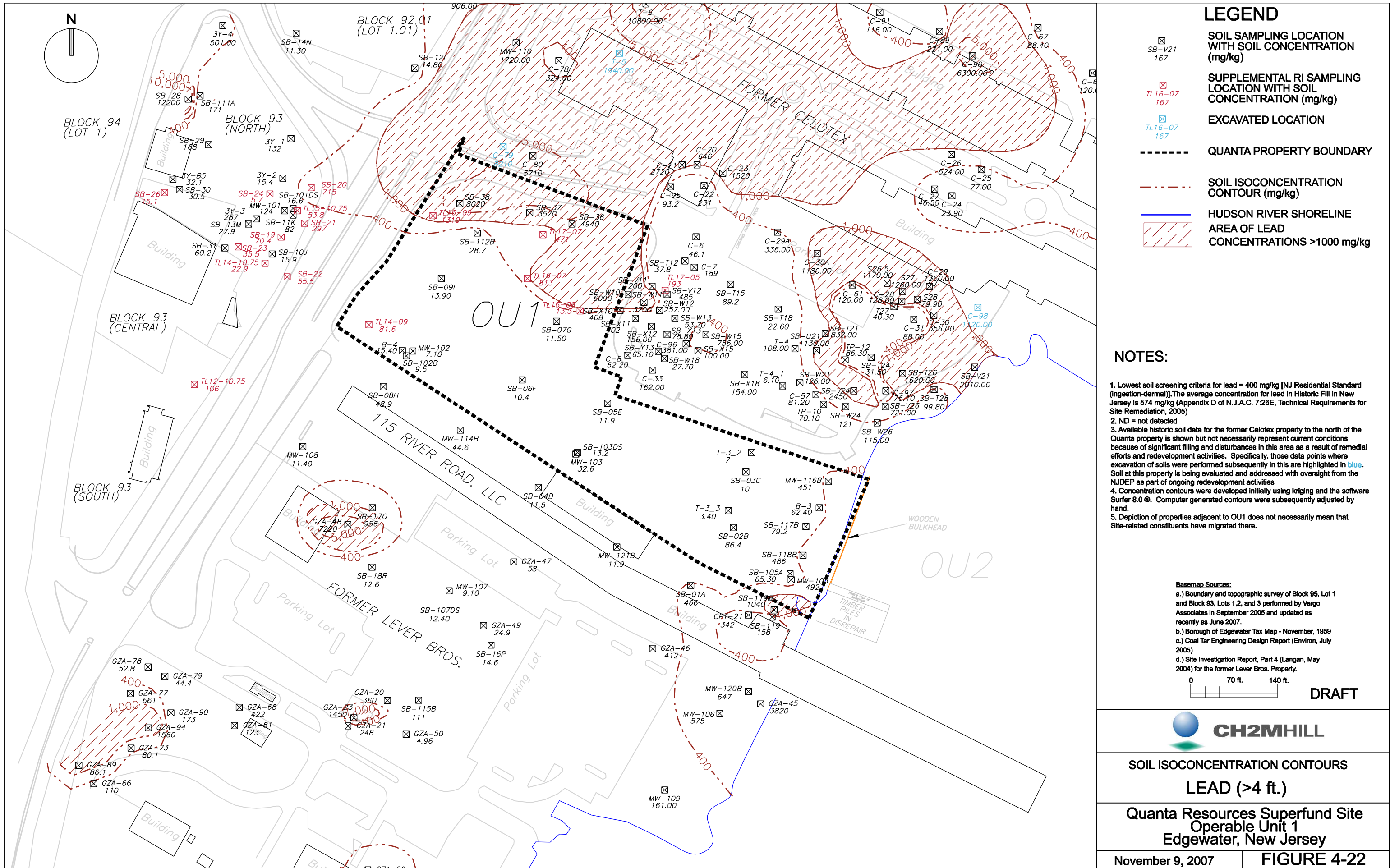




Figure 4-23 is Superseded by Figure 5-1 of the Final SRI Report

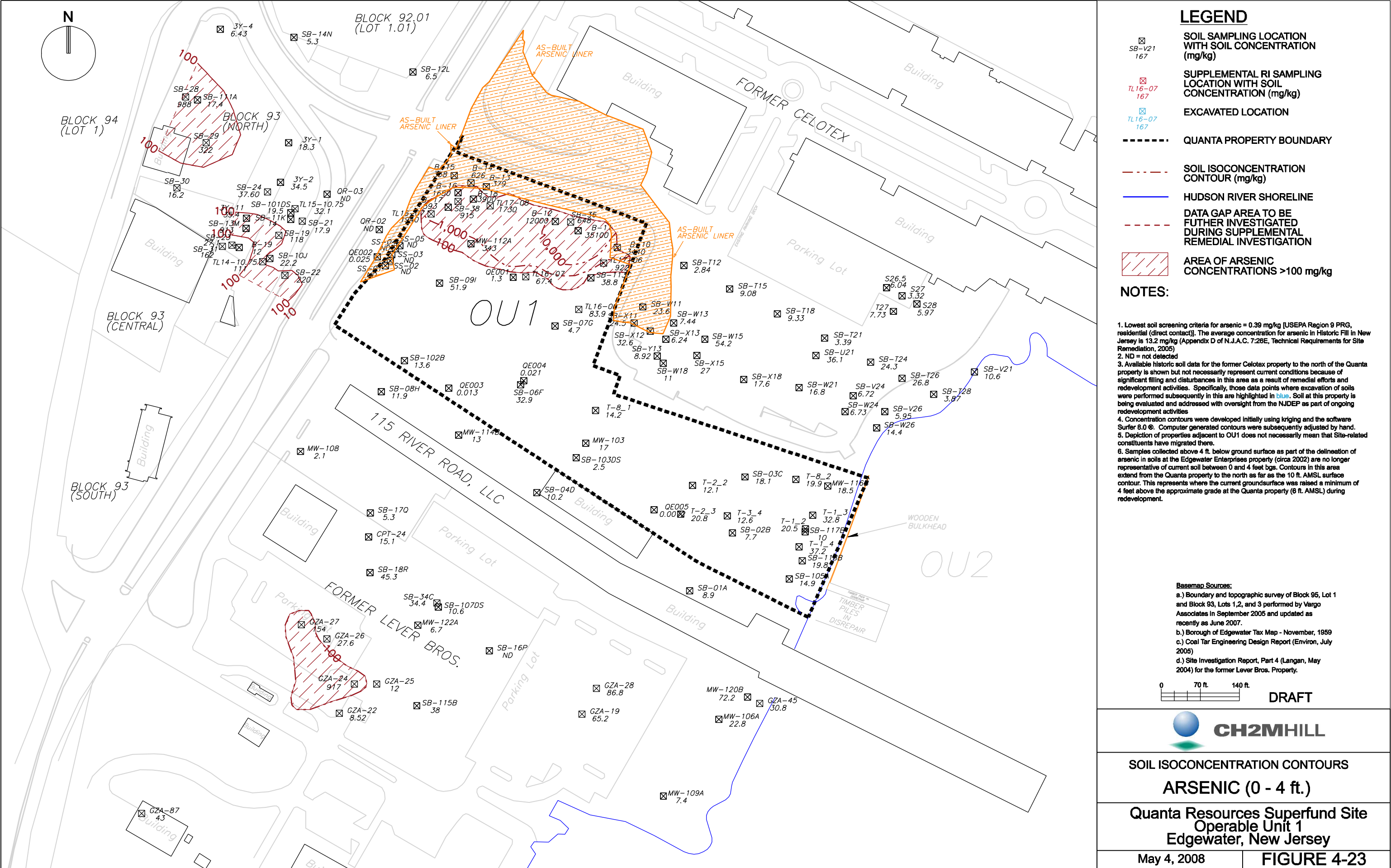
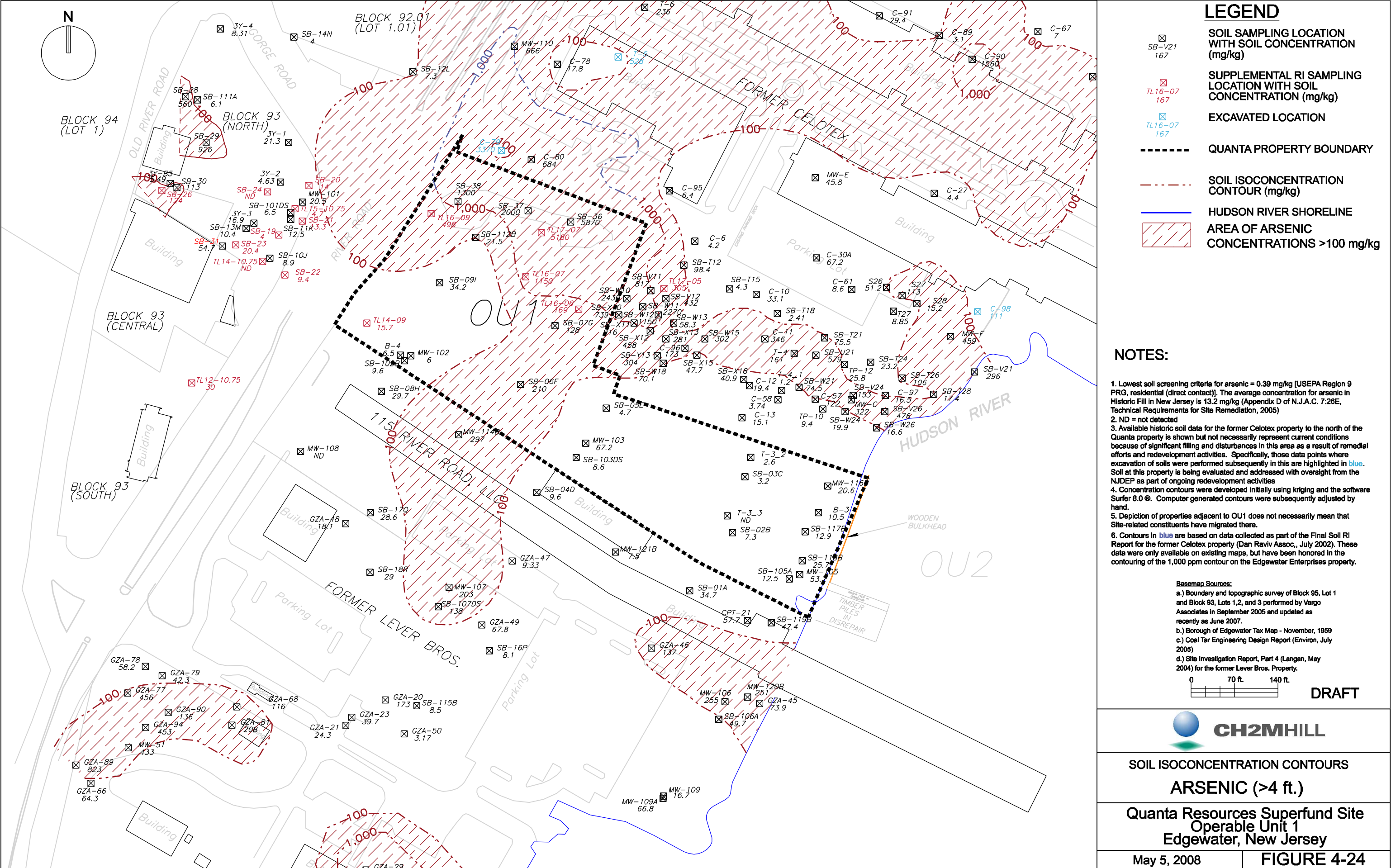
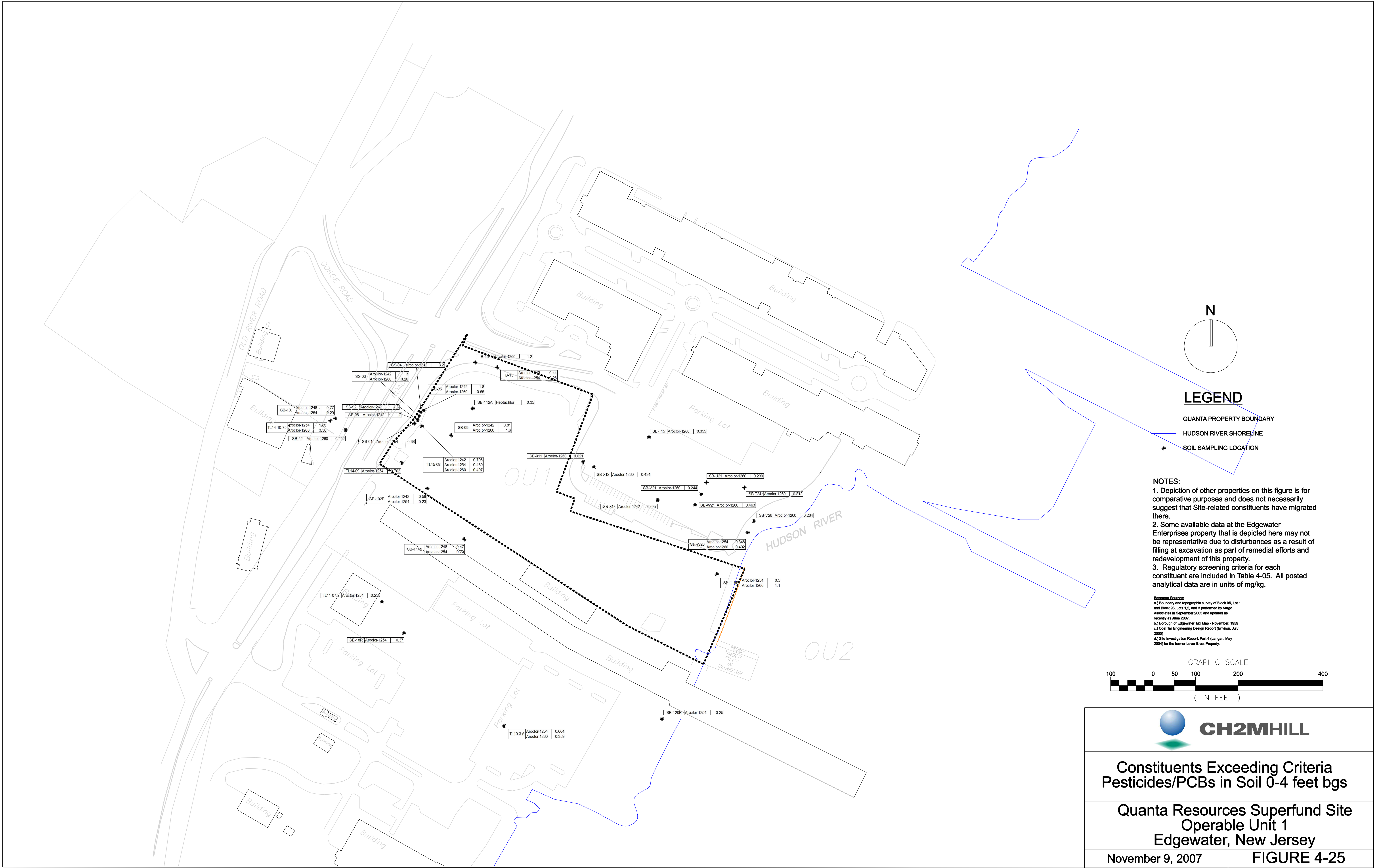


Figure 4-24 is Superseded by Figure 5-2 of the Final SRI Report













**Figure 4-27 is Superseded by Figure 4-8 of the Final SRI Report**

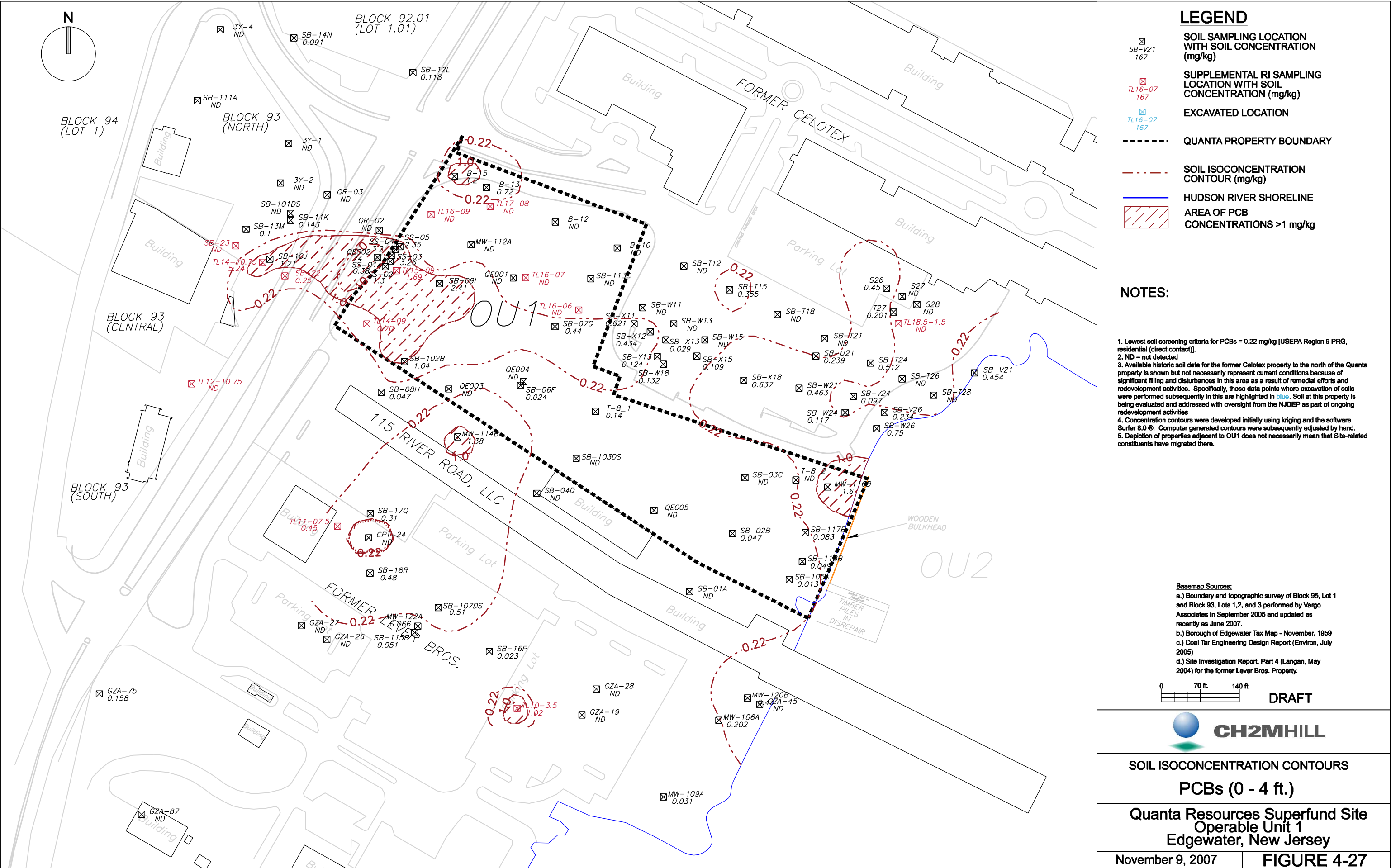
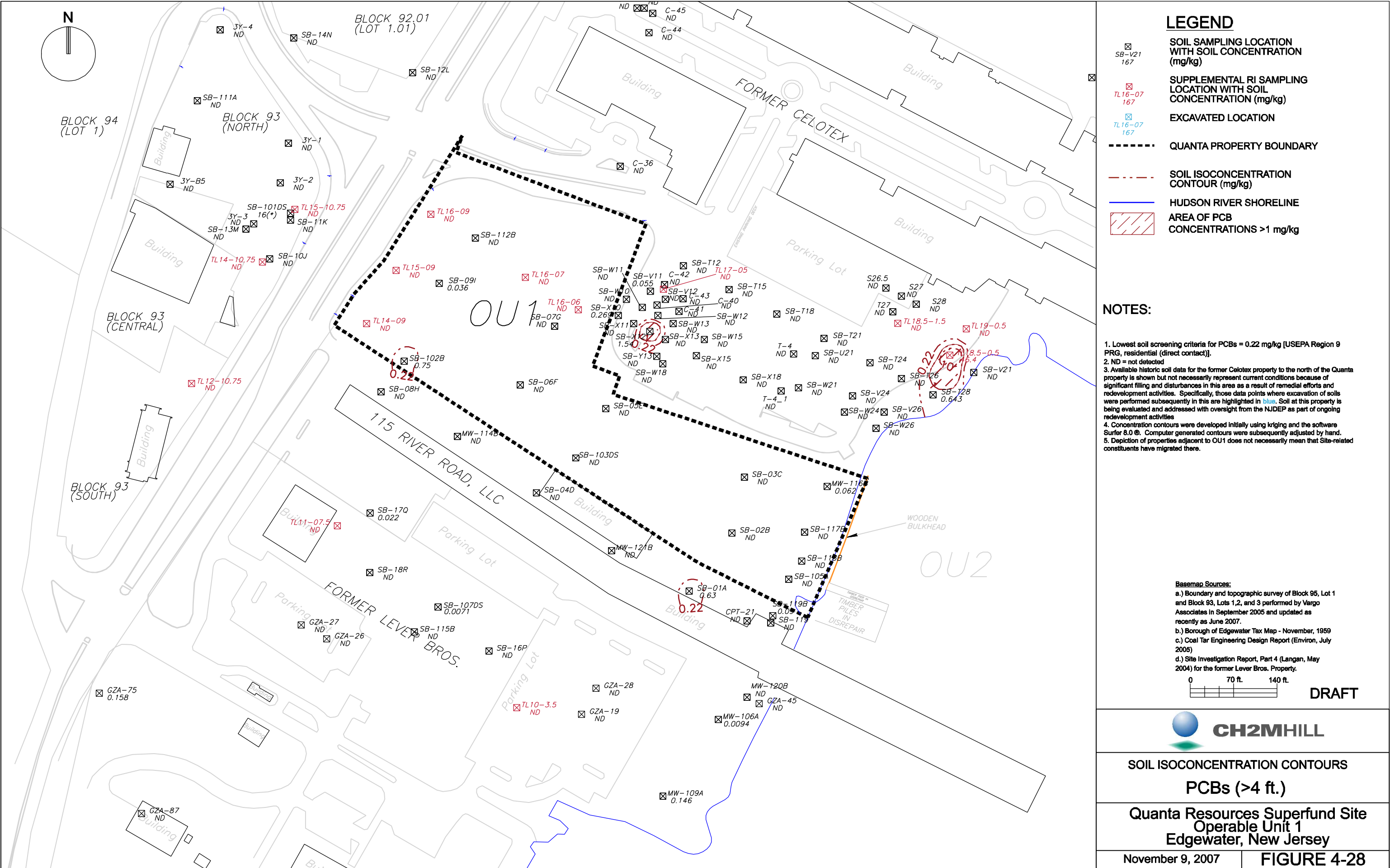


Figure 4-28 is Superseded by Figure 4-9 of the Final SRI Report





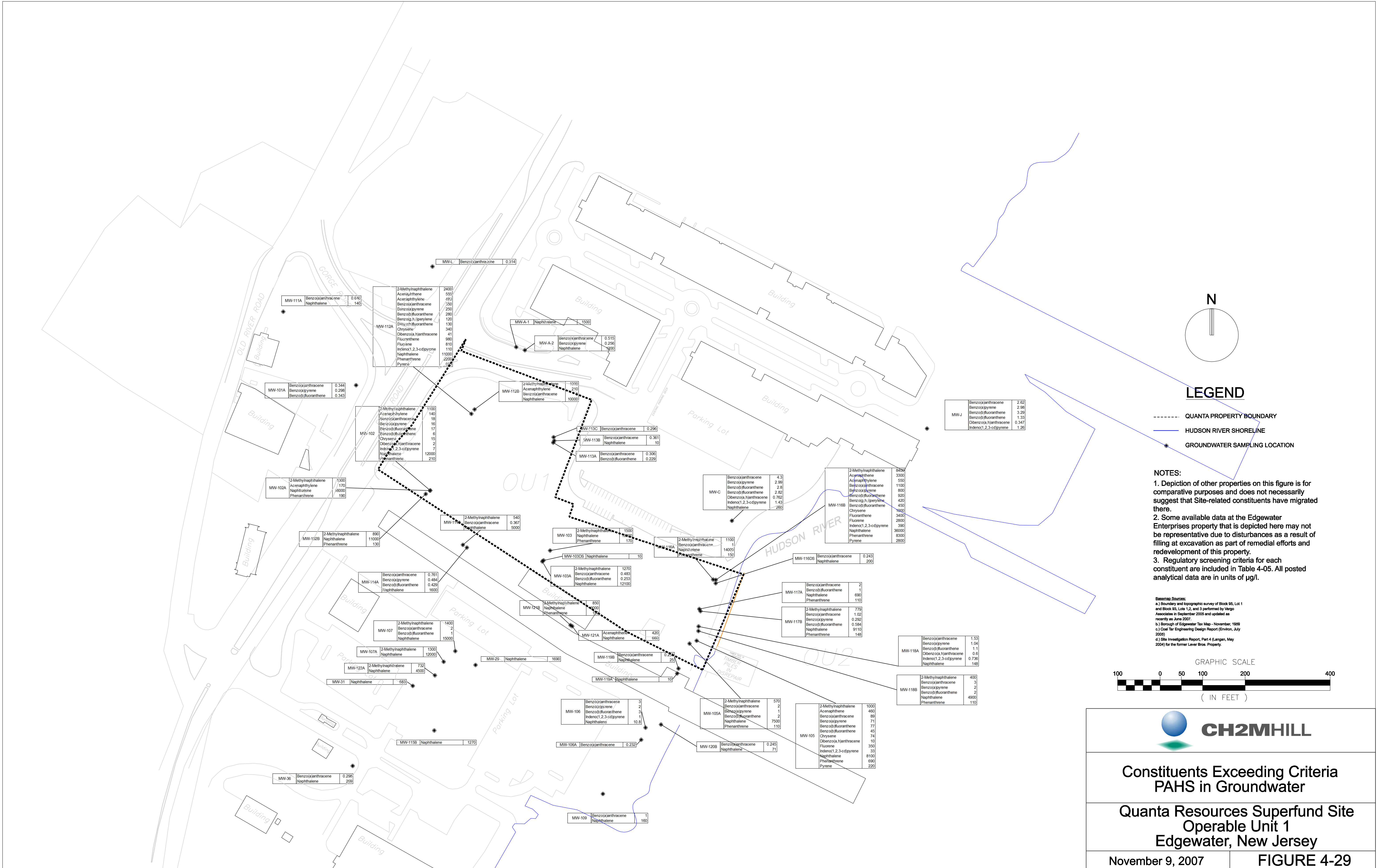




Figure 4-30 is Superseded by Figure 4-10 of the Final SRI Report

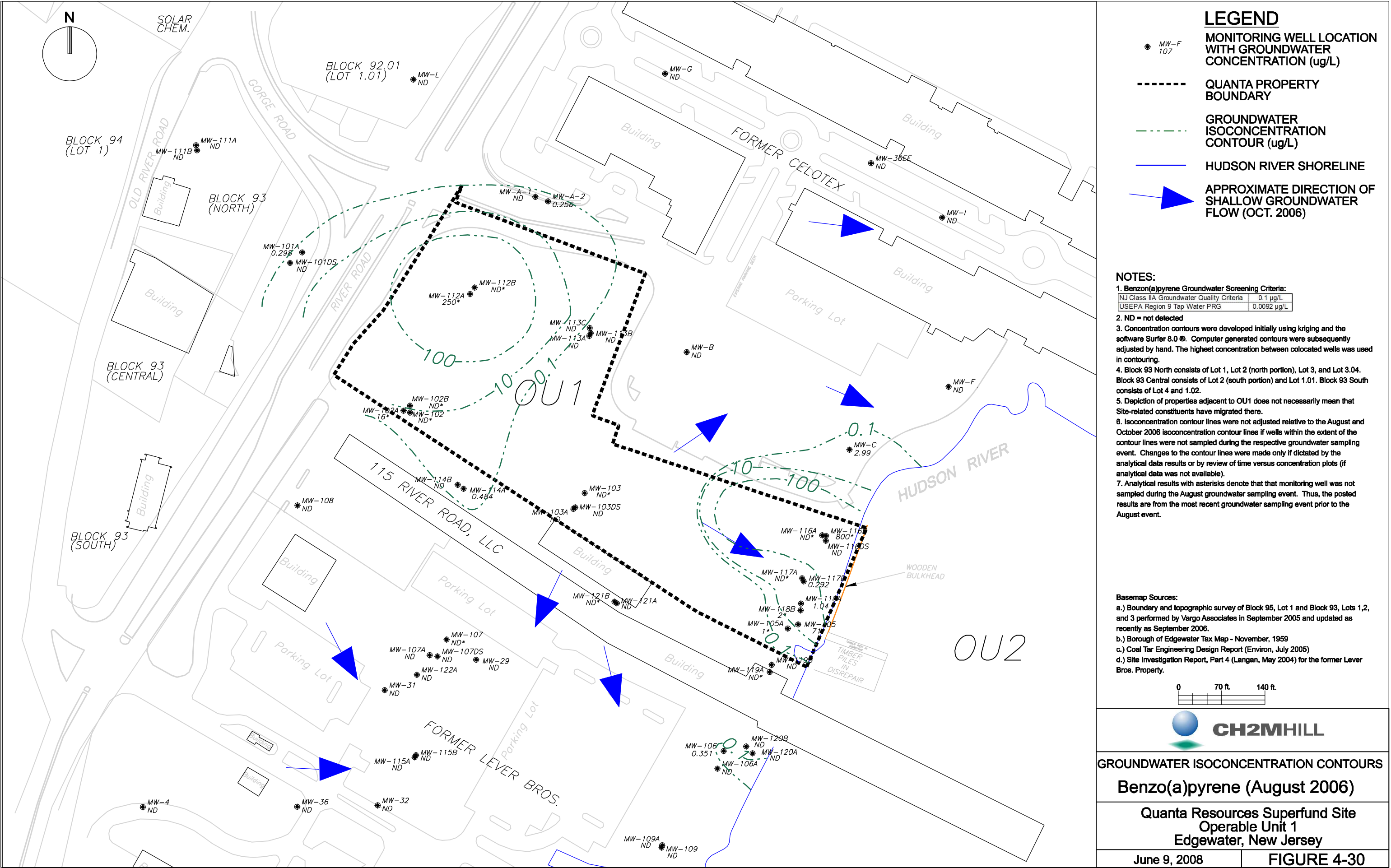
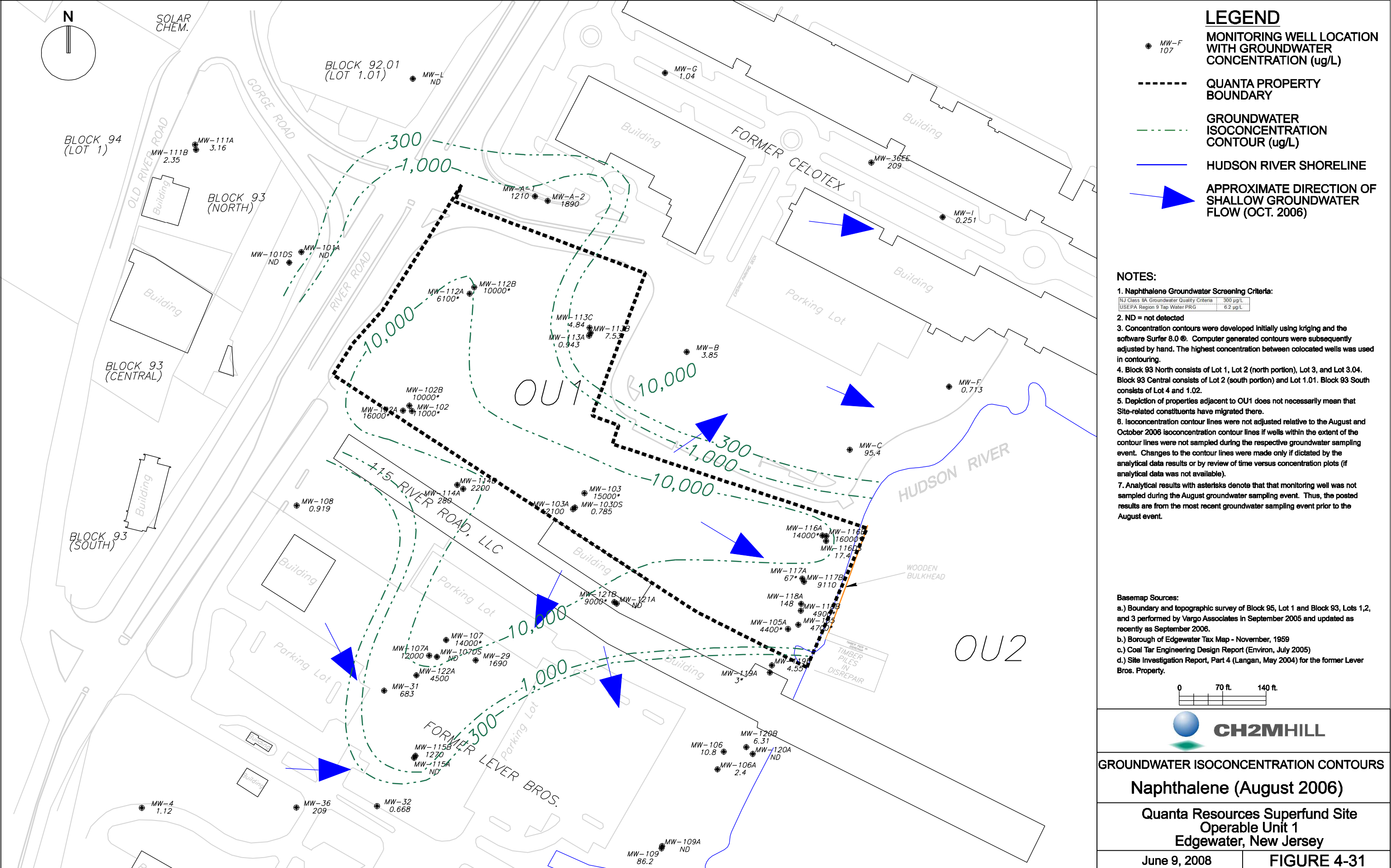


Figure 4-31 is Superseded by Figure 4-12 of the Final SRI Report

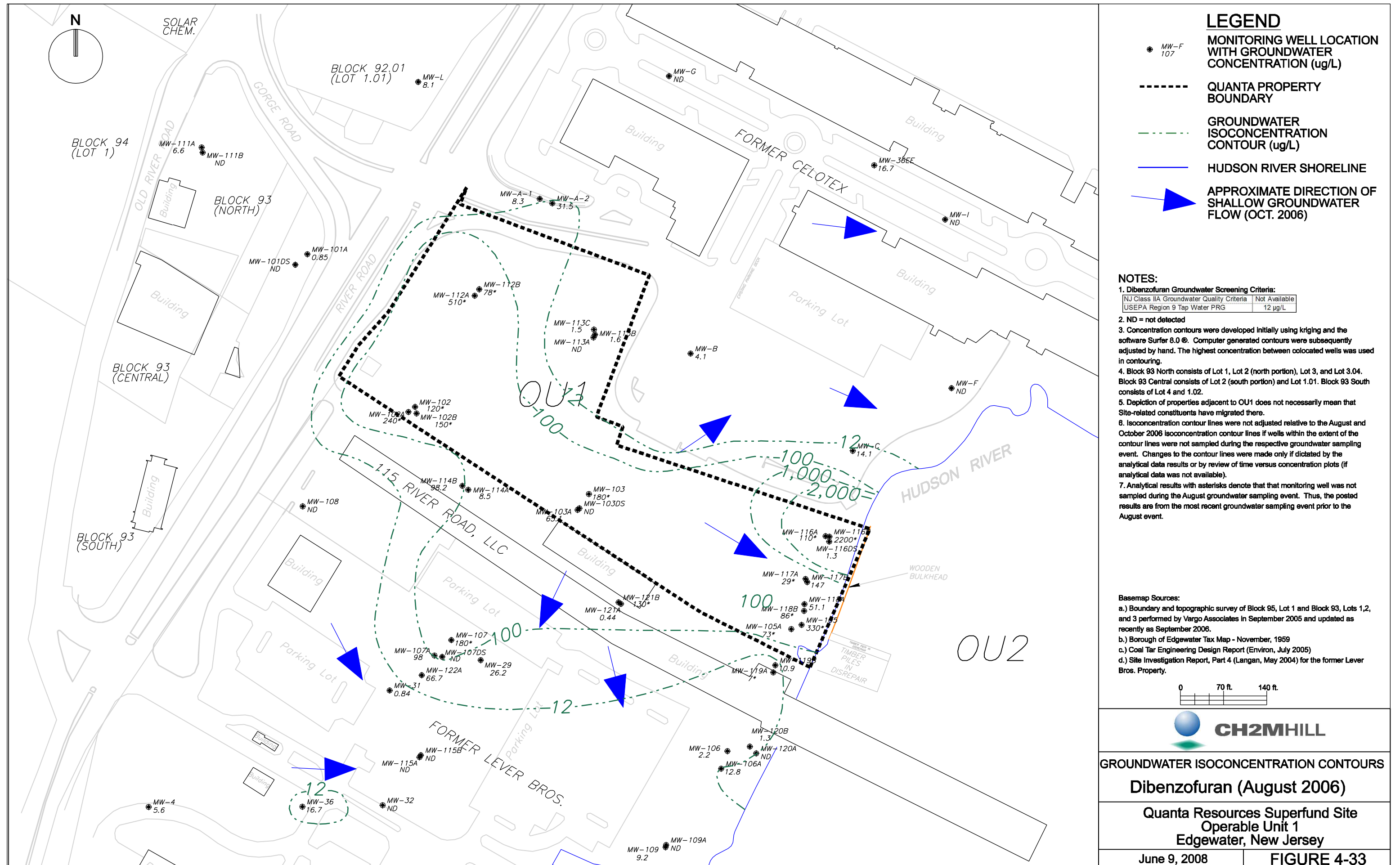




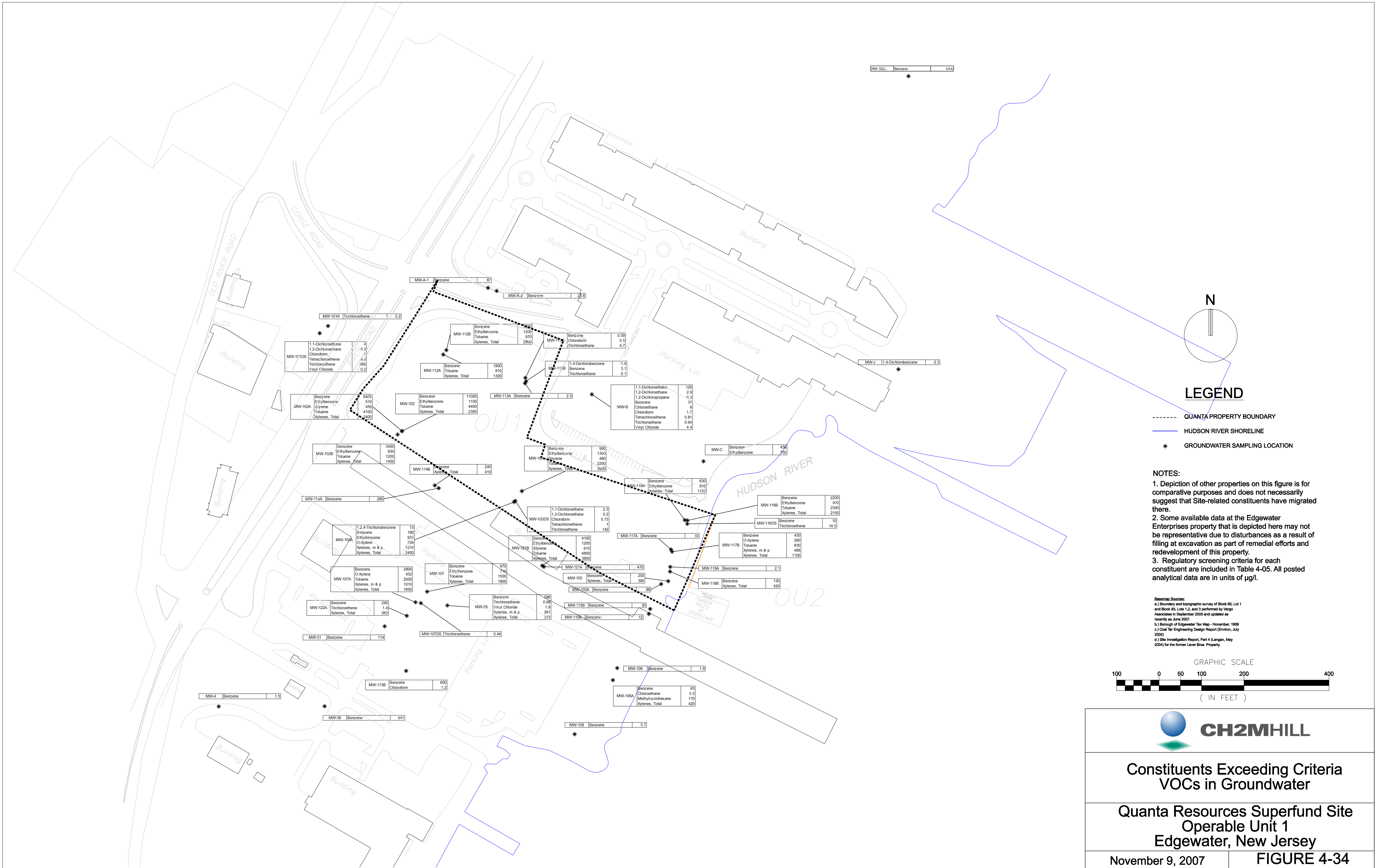




**Figure 4-33 is Superseded by Figure 4-13 of the Final SRI Report**

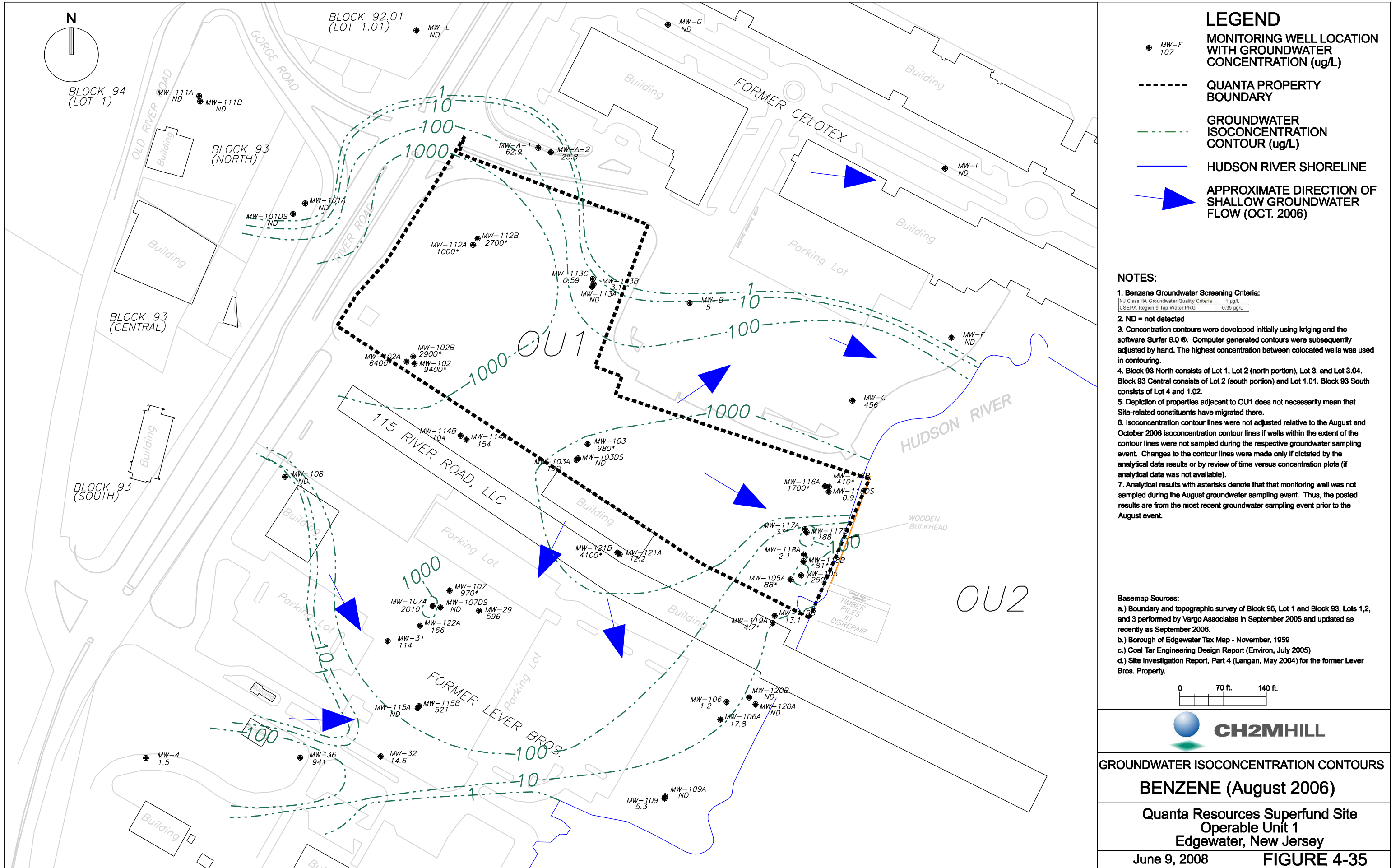








**Figure 4-35 is Superseded by Figure 4-11 of the Final SRI Report**





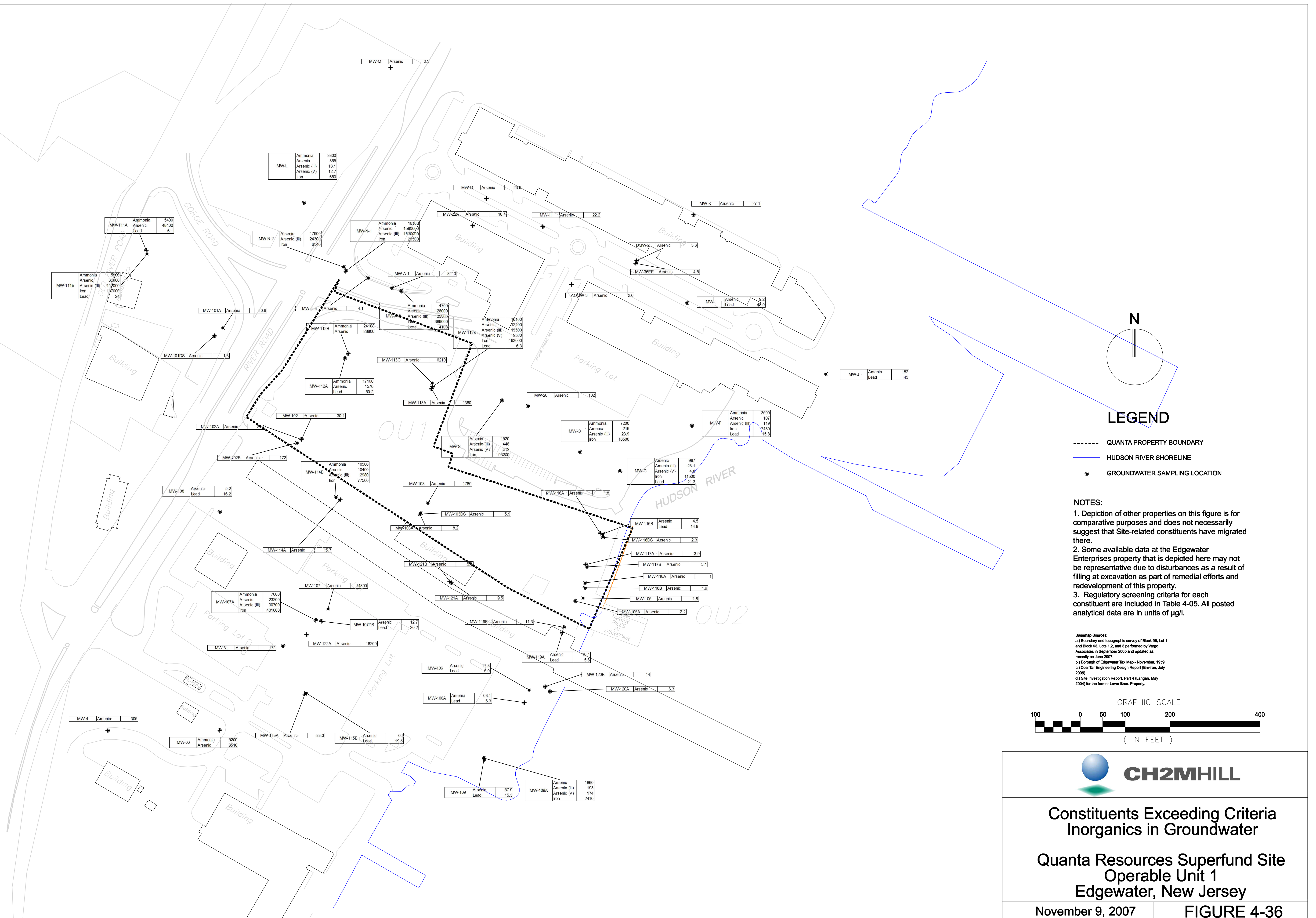




Figure 4-37 is Superseded by Figure 5-7 of the Final SRI Report

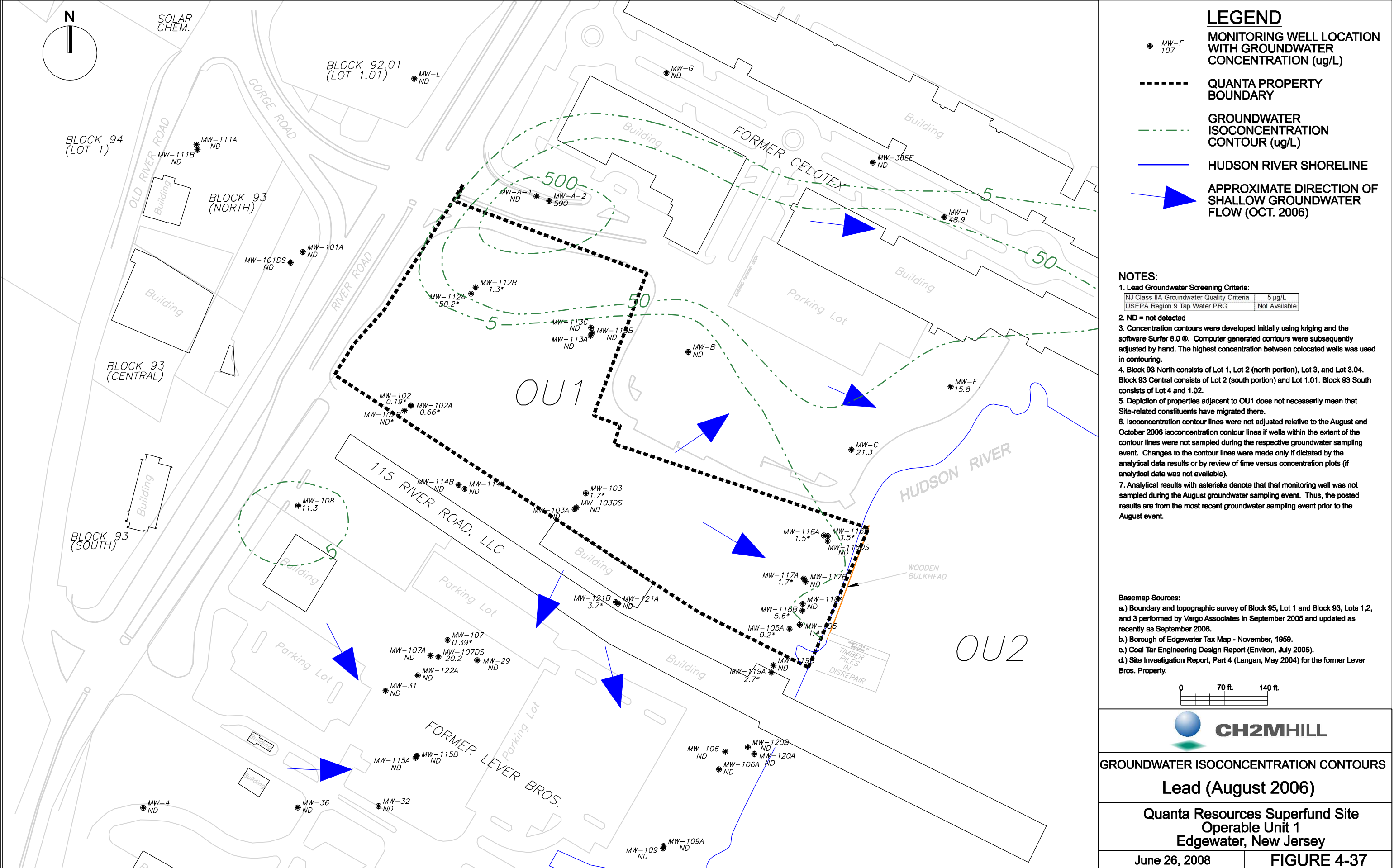
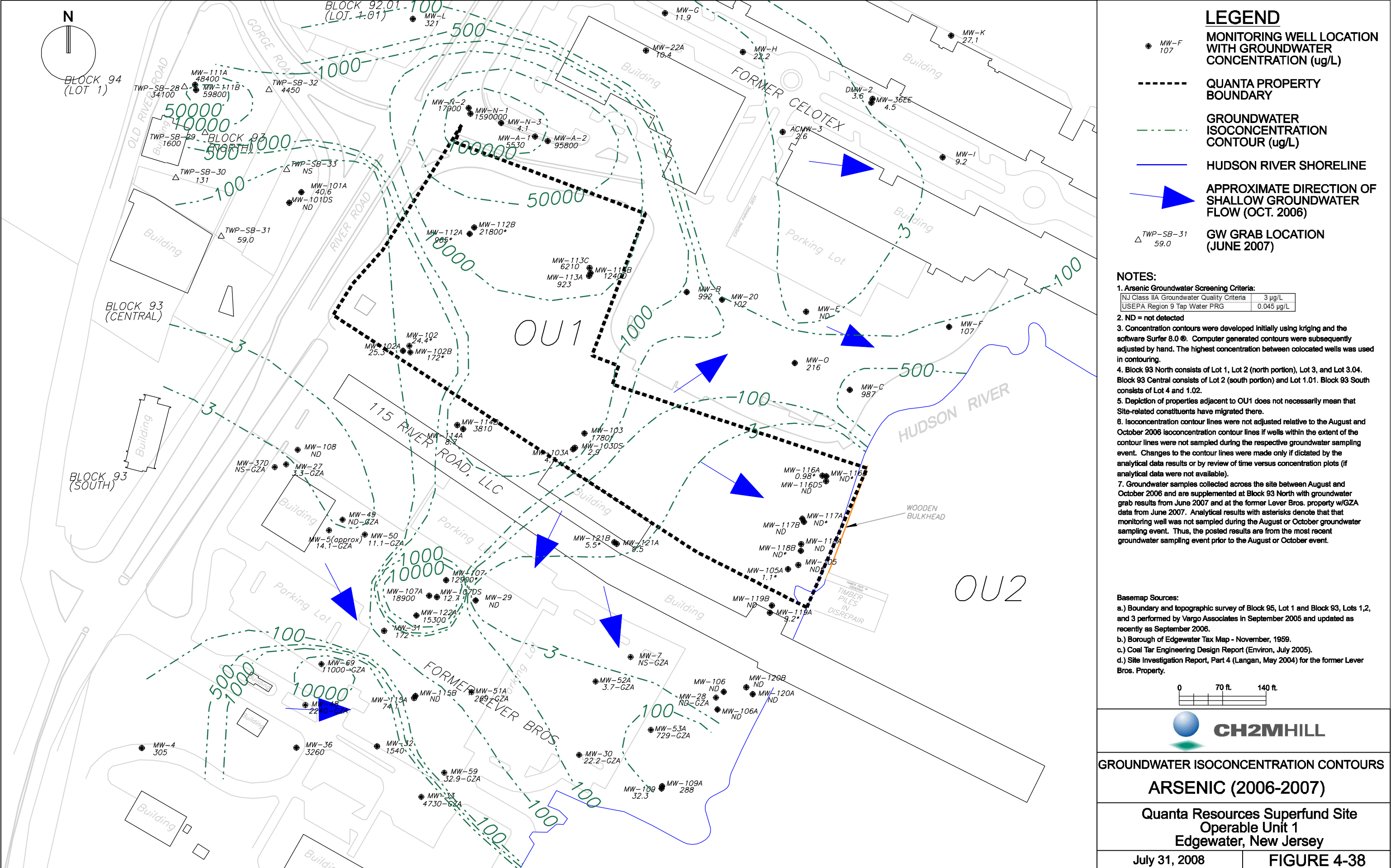
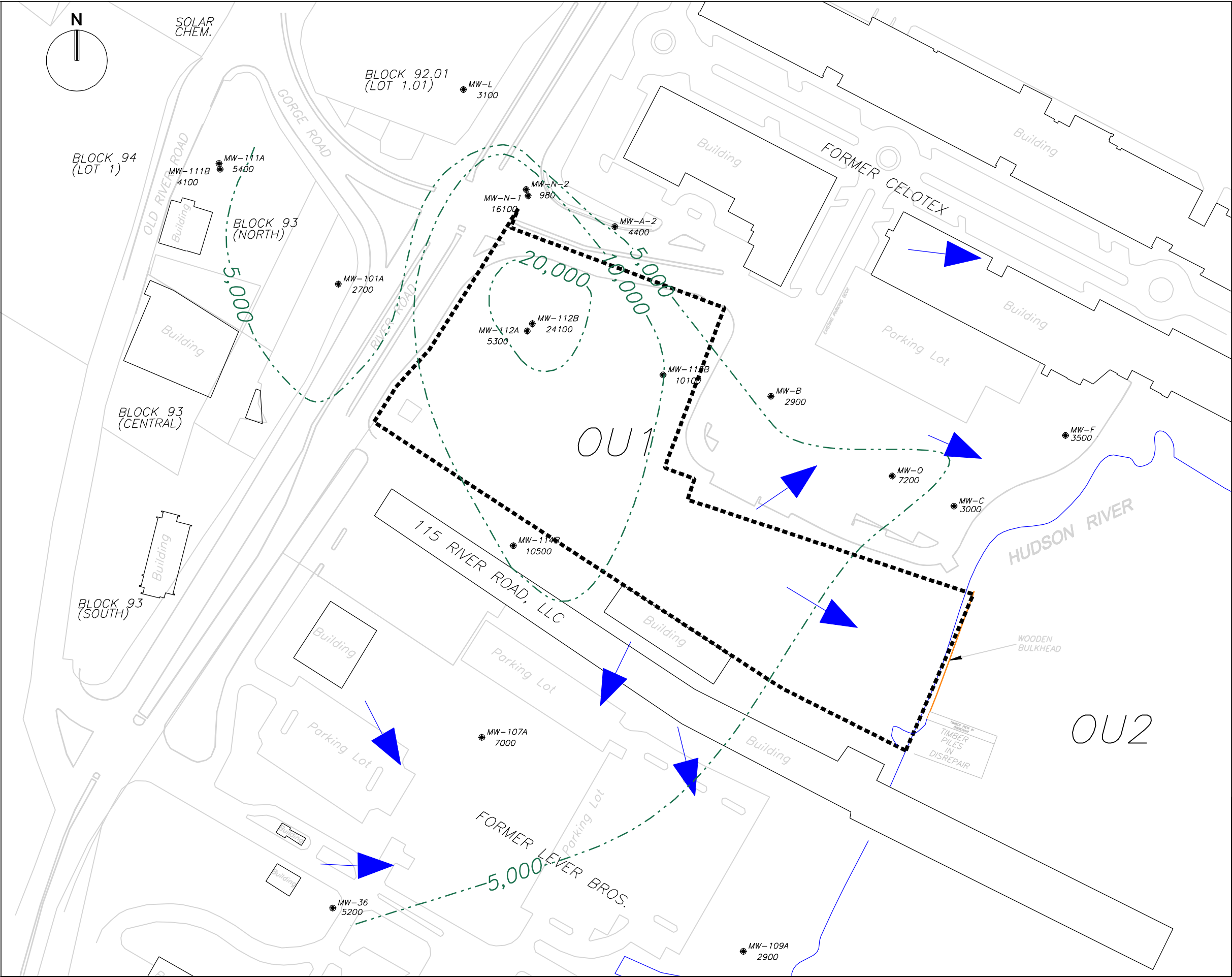


Figure 4-38 is Superseded by Figure 5-5 of the Final SRI Report







LEGEND

MW-F  
107

MONITORING WELL LOCATION  
WITH GROUNDWATER  
CONCENTRATION (ug/L)

QUANTA PROPERTY  
BOUNDARY

GROUNDWATER  
ISOCONCENTRATION  
CONTOUR (ug/L)

HUDSON RIVER SHORELINE

APPROXIMATE DIRECTION OF  
SHALLOW GROUNDWATER  
FLOW (OCT. 2006)

- NOTES:
1. Ammonia Groundwater Screening Criteria:

NJ Class IIA Groundwater Quality Criteria	3000 ug/L
USEPA Region 9 Tap Water PRG	Not Available
2. ND = not detected
3. Concentration contours were developed initially using kriging and the software Surfer 8.0®. Computer generated contours were subsequently adjusted by hand. The highest concentration between colocated wells was used in contouring.
4. Block 93 North consists of Lot 1, Lot 2 (north portion), Lot 3, and Lot 3.04. Block 93 Central consists of Lot 2 (south portion) and Lot 1.01. Block 93 South consists of Lot 4 and 1.02.
5. Depiction of properties adjacent to OU1 does not necessarily mean that Site-related constituents have migrated there.
6. Isoconcentration contour lines were not adjusted relative to the August and October 2006 isoconcentration contour lines if wells within the extent of the contour lines were not sampled during the respective groundwater sampling event. Changes to the contour lines were made only if dictated by the analytical data results or by review of time versus concentration plots (if analytical data was not available).
7. Groundwater concentrations represent those samples collected across the Site between August and October 2006.

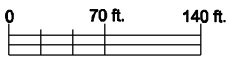
Basemap Sources:

a.) Boundary and topographic survey of Block 95, Lot 1 and Block 93, Lots 1,2, and 3 performed by Vargo Associates in September 2005 and updated as recently as September 2006.

b.) Borough of Edgewater Tax Map - November, 1959

c.) Coal Tar Engineering Design Report (Environ, July 2005)

d.) Site Investigation Report, Part 4 (Langan, May 2004) for the former Lever Bros. Property.



GROUNDWATER ISOCONCENTRATION CONTOURS

Ammonia (August/October 2006)

Quanta Resources Superfund Site

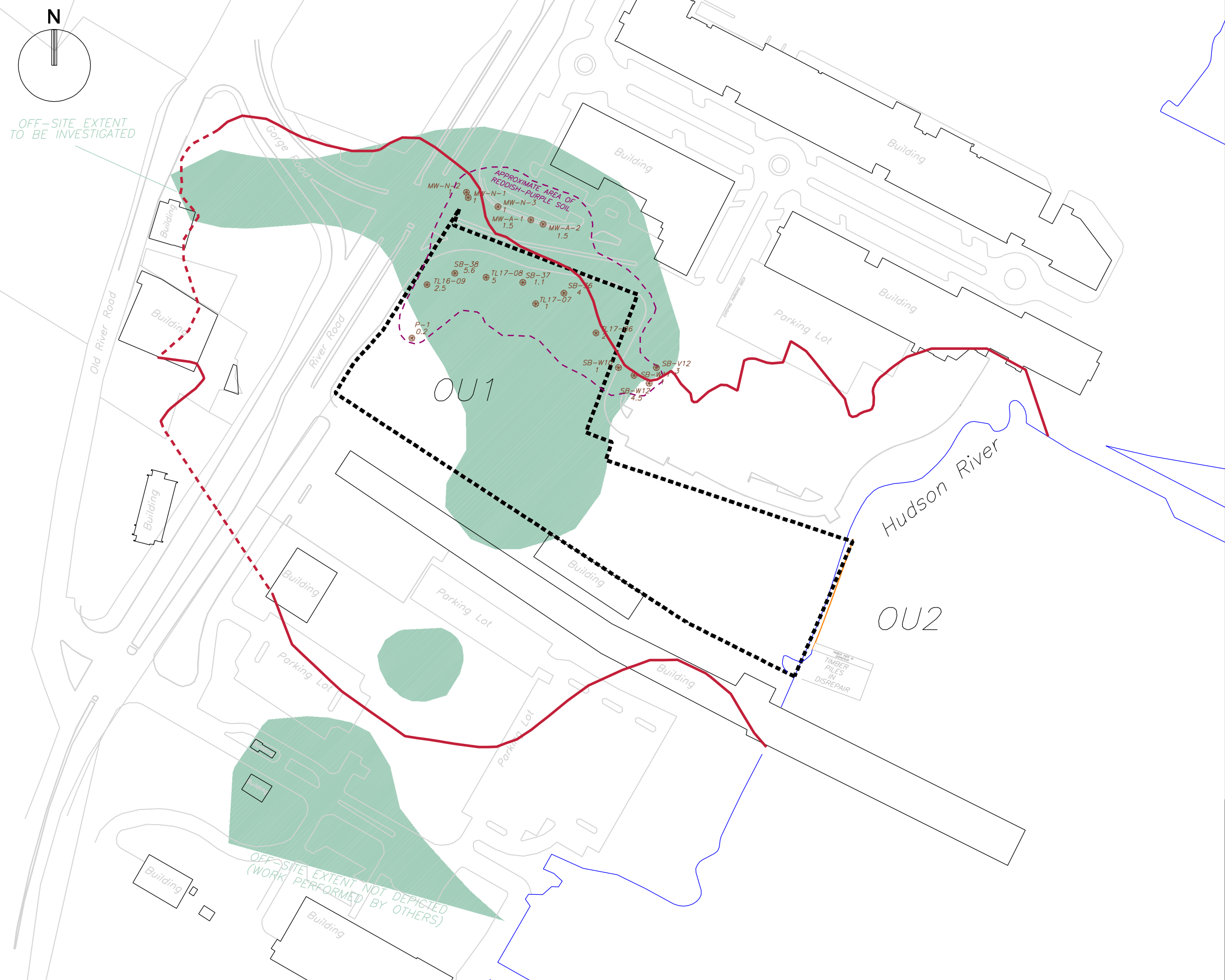
Operable Unit 1

Edgewater, New Jersey

June 9, 2008

FIGURE 4-39a

306313



# LEGEND

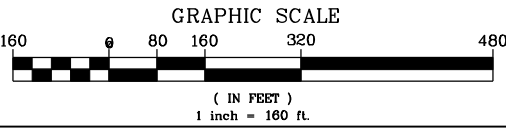
- AREA OF GROUNDWATER WHERE ARSENIC CONCENTRATIONS ARE GREATER THAN 1000 ug/L
- BORING LOCATION WITH DEPTH (FT BGS) AT WHICH REDDISH-PURPLE SOILS OBSERVED
- CURRENT QUANTA PROPERTY BOUNDARY
- LATERAL EXTENT OF COAL TAR BASED ON TarGOST®, SOIL BORING AND MONITORING WELL OBSERVATIONS. INCLUDES STAINED AND ODOROUS SOILS WHERE NAPL WAS NOT OBSERVED (DASHED WHERE ADDITIONAL DELINEATION NEEDED)
- APPROXIMATE AREA OF REDDISH-PURPLE SOIL

## NOTES:

- The extent of reddish-purple soil is based on observations and soil sampling results from extensive borings and soil sampling programs performed at the former Celotex property, the Quanta property, and to the west within River Road and beyond. Due to the large number of soil observations all locations could not be shown on this figure.
- For detailed notes on the depiction of arsenic in groundwater please refer to Figure 4-38.
- Depiction of other properties on this figure is for comparative purposes and does not necessarily suggest that site-related constituents have migrated there.

## Basemap Sources:

- Boundary and topographic survey of Block 95, Lot 1 and Block 93, Lots 1,2, and 3 performed by Vargo Associates in September 2005 and updated as recently as June 2007.
- Borough of Edgewater Tax Map - November, 1959.
- Coal Tar Engineering Design Report (Environ, July 2005).
- Site Investigation Report, Part 4 (Langan, May 2004) for the former Lever Bros. Property.



Extent of Reddish-Purple Soils, Arsenic in Groundwater, and Coal Tar

Quanta Resources Superfund Site  
Operable Unit 1  
Edgewater, New Jersey

June 26, 2008

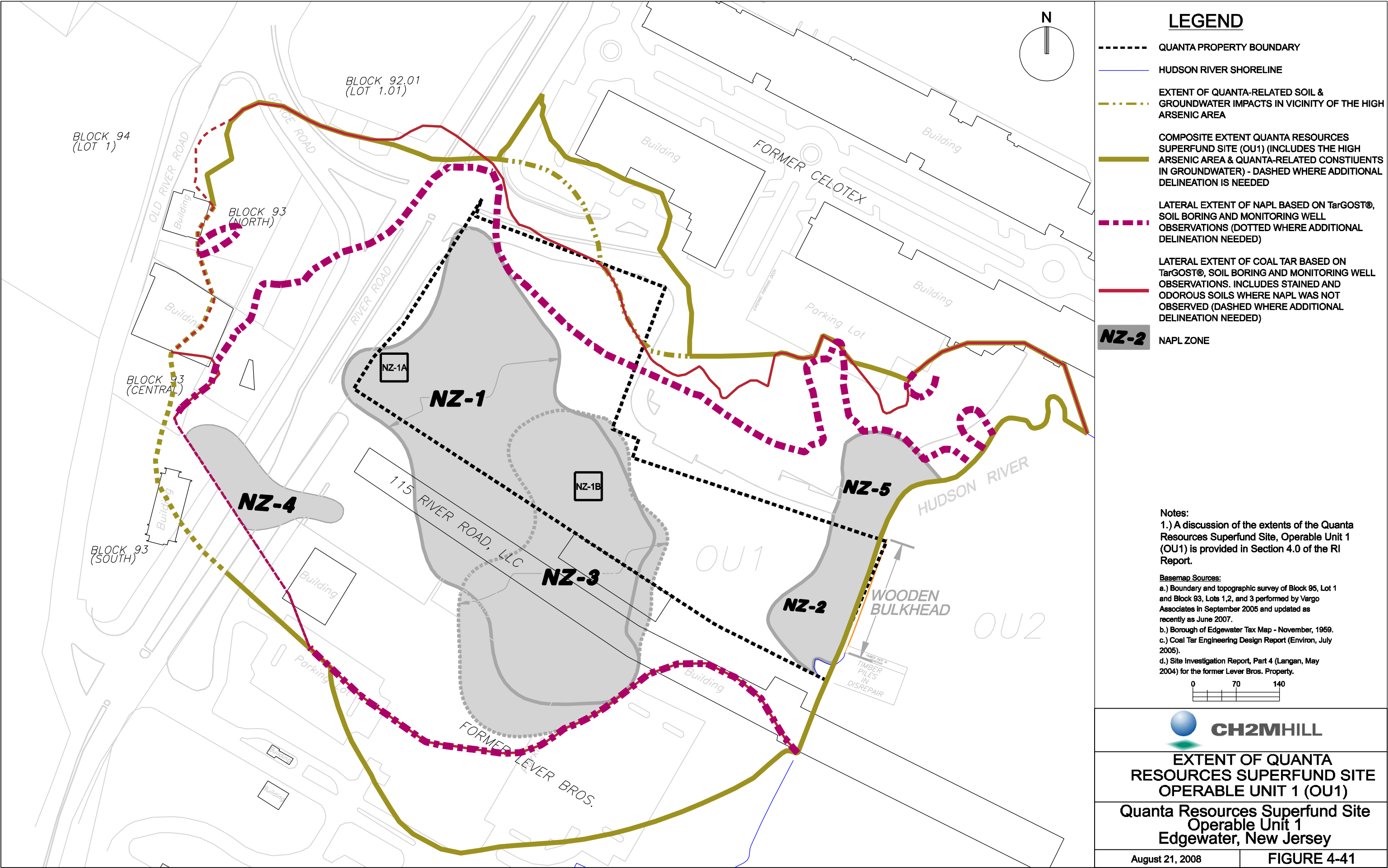
FIGURE 4-39b



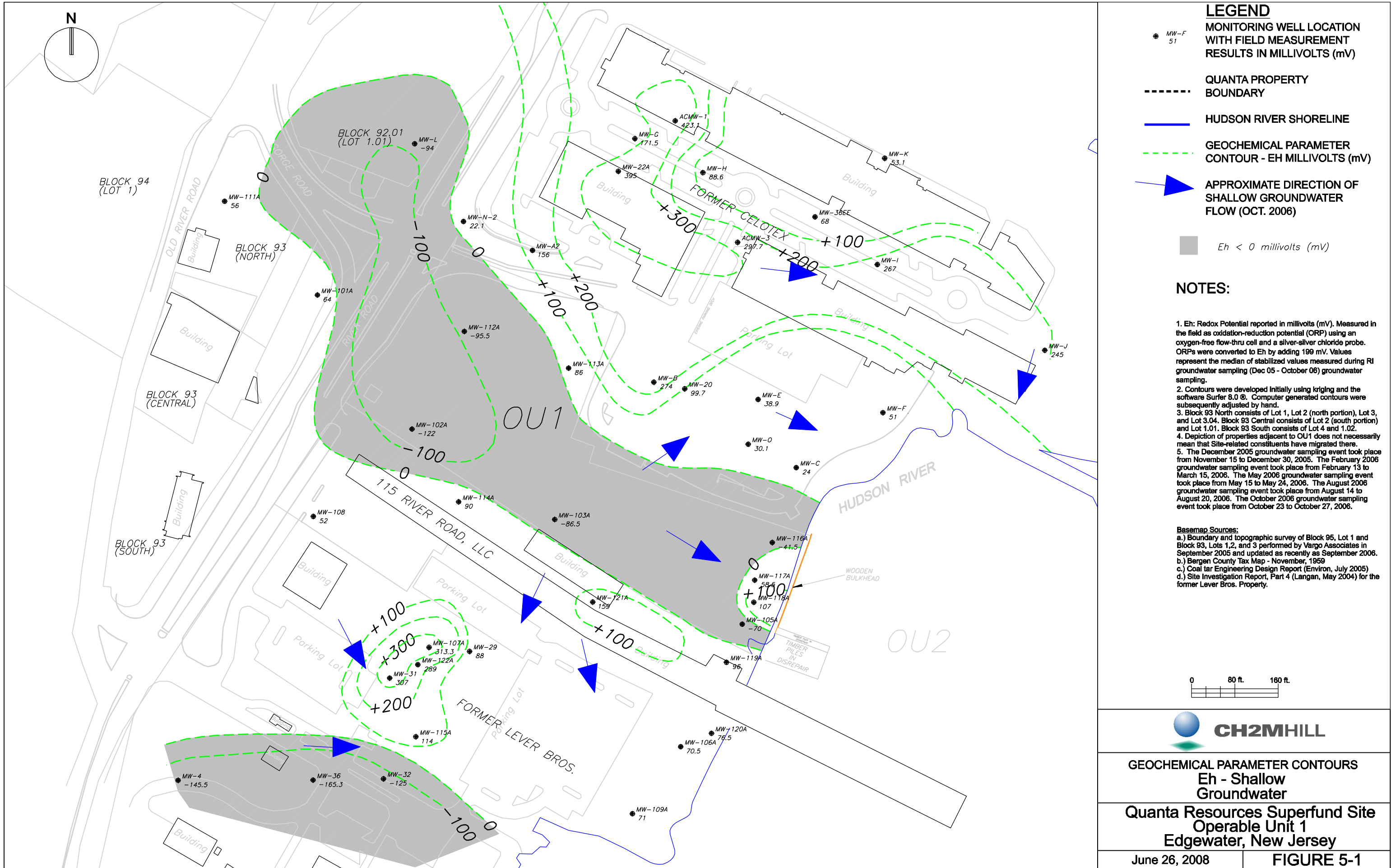




Figure 4-41 is Superseded by Figure 8-1 of the Final SRI Report

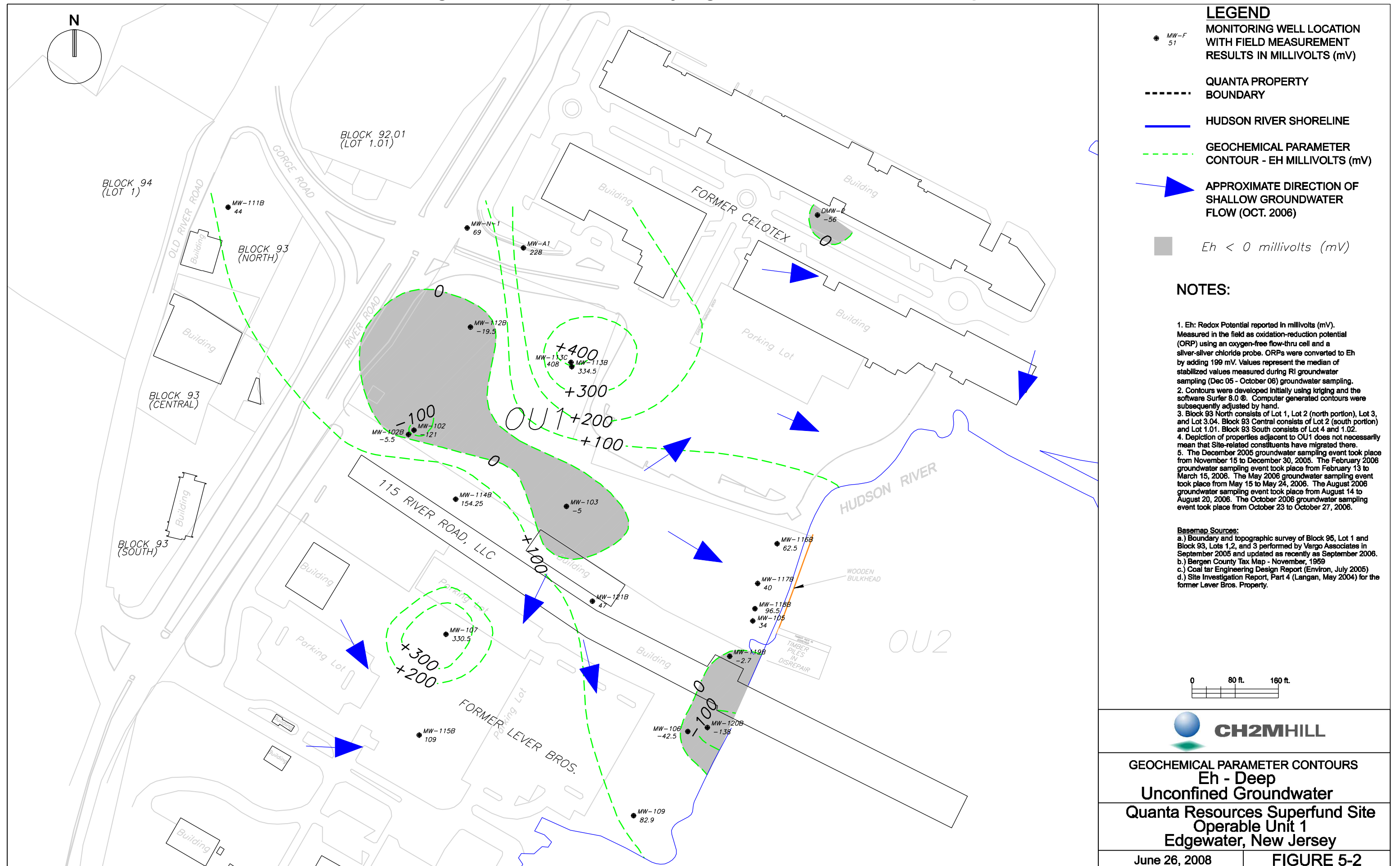


**Figure 5-1 is Superseded by Figure 5-10 of the Final SRI Report**





**Figure 5-2 is Superseded by Figure 5-11 of the Final SRI Report**



**LEGEND**

- MONITORING WELL LOCATION WITH FIELD MEASUREMENT RESULTS IN pH (SU)
- QUANTA PROPERTY BOUNDARY
- HUDSON RIVER SHORELINE
- GEOCHEMICAL PARAMETER CONTOUR - pH (SU)
- APPROXIMATE DIRECTION OF SHALLOW GROUNDWATER FLOW (OCT. 2006)
- pH < 5.5

**NOTES:**

- pH measured in the field using an oxygen-free flow-thru cell. Values represent the median of stabilized pH values measured during RI groundwater sampling (Dec 05 - October 06) groundwater sampling.
- Contours were developed initially using kriging and the software Surfer 8.0. Computer generated contours were subsequently adjusted by hand.
- Block 93 North consists of Lot 1, Lot 2 (north portion), Lot 3, and Lot 3.04. Block 93 Central consists of Lot 2 (south portion) and Lot 1.01. Block 93 South consists of Lot 4 and 1.02.
- Depiction of properties adjacent to OU1 does not necessarily mean that Site-related constituents have migrated there.
- The December 2005 groundwater sampling event took place from November 15 to December 30, 2005. The February 2006 groundwater sampling event took place from February 13 to March 15, 2006. The May 2006 groundwater sampling event took place from May 15 to May 24, 2006. The August 2006 groundwater sampling event took place from August 14 to August 20, 2006. The October 2006 groundwater sampling event took place from October 23 to October 27, 2006.

**Basemap Sources:**

- Boundary and topographic survey of Block 95, Lot 1 and Block 93, Lots 1, 2, and 3 performed by Vargo Associates in September 2005 and updated as recently as September 2006.
- Bergen County Tax Map - November, 1959
- Coal tar Engineering Design Report (Environ, July 2005)
- Site Investigation Report, Part 4 (Langan, May 2004) for the former Lever Bros. Property.

**CH2MHILL**

**GEOCHEMICAL PARAMETER CONTOURS**

**pH - Shallow Groundwater**

**Quanta Resources Superfund Site**

**Operable Unit 1**

**Edgewater, New Jersey**

June 26, 2008

**FIGURE 5-3**

**Figure 5-4 is Superseded by Figure 5-13 of the Final SRI Report**

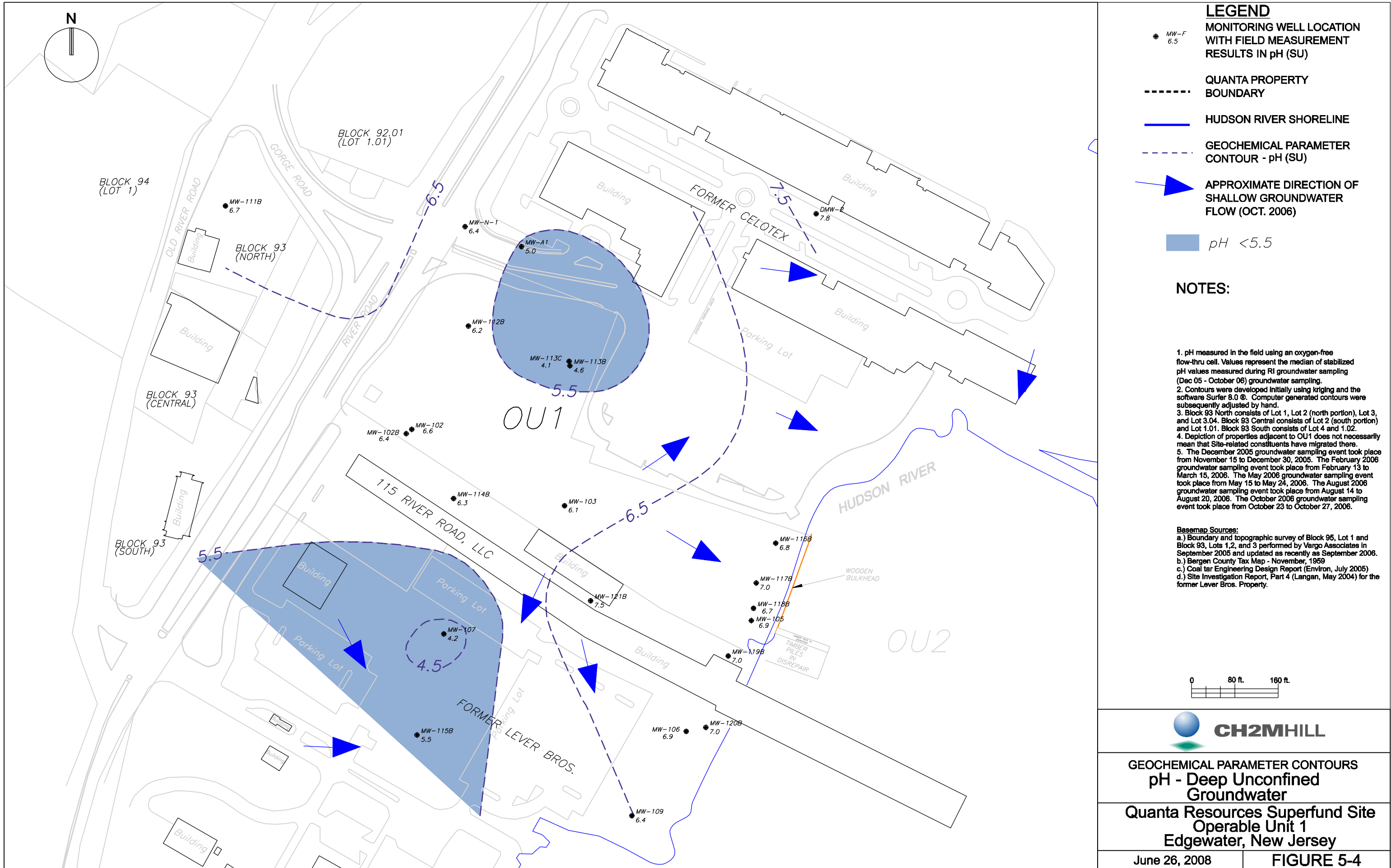
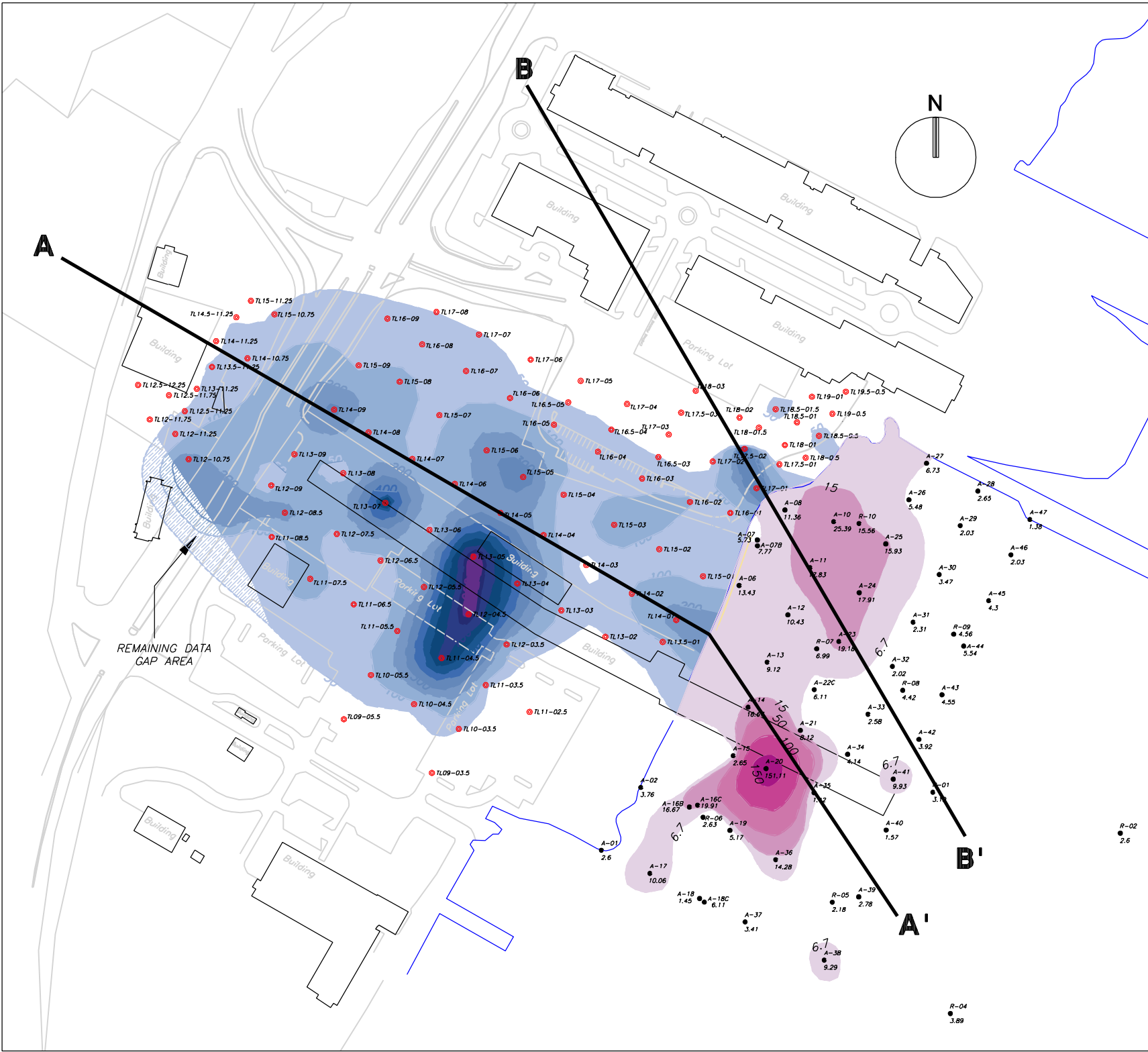
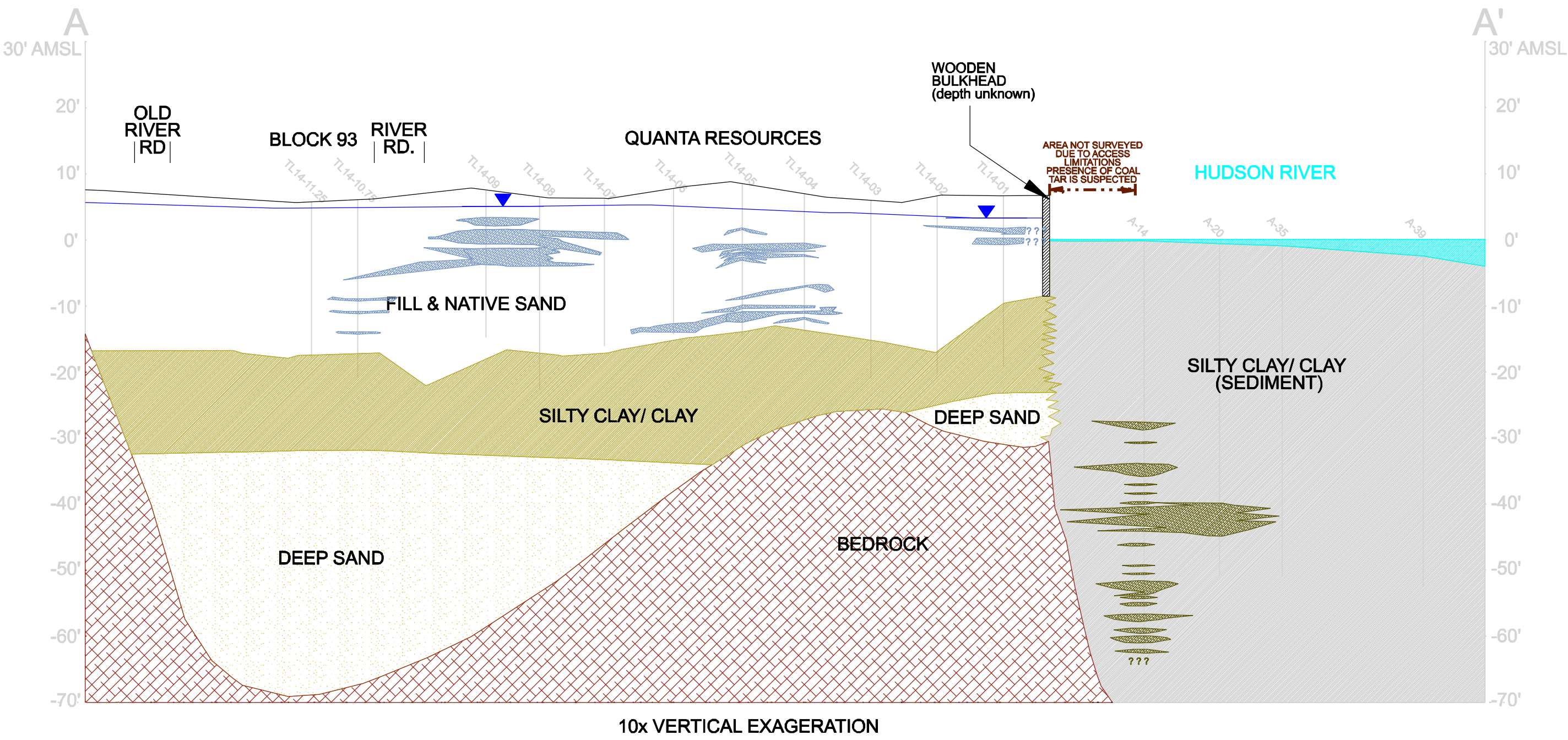
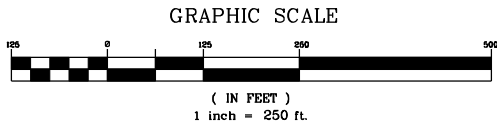




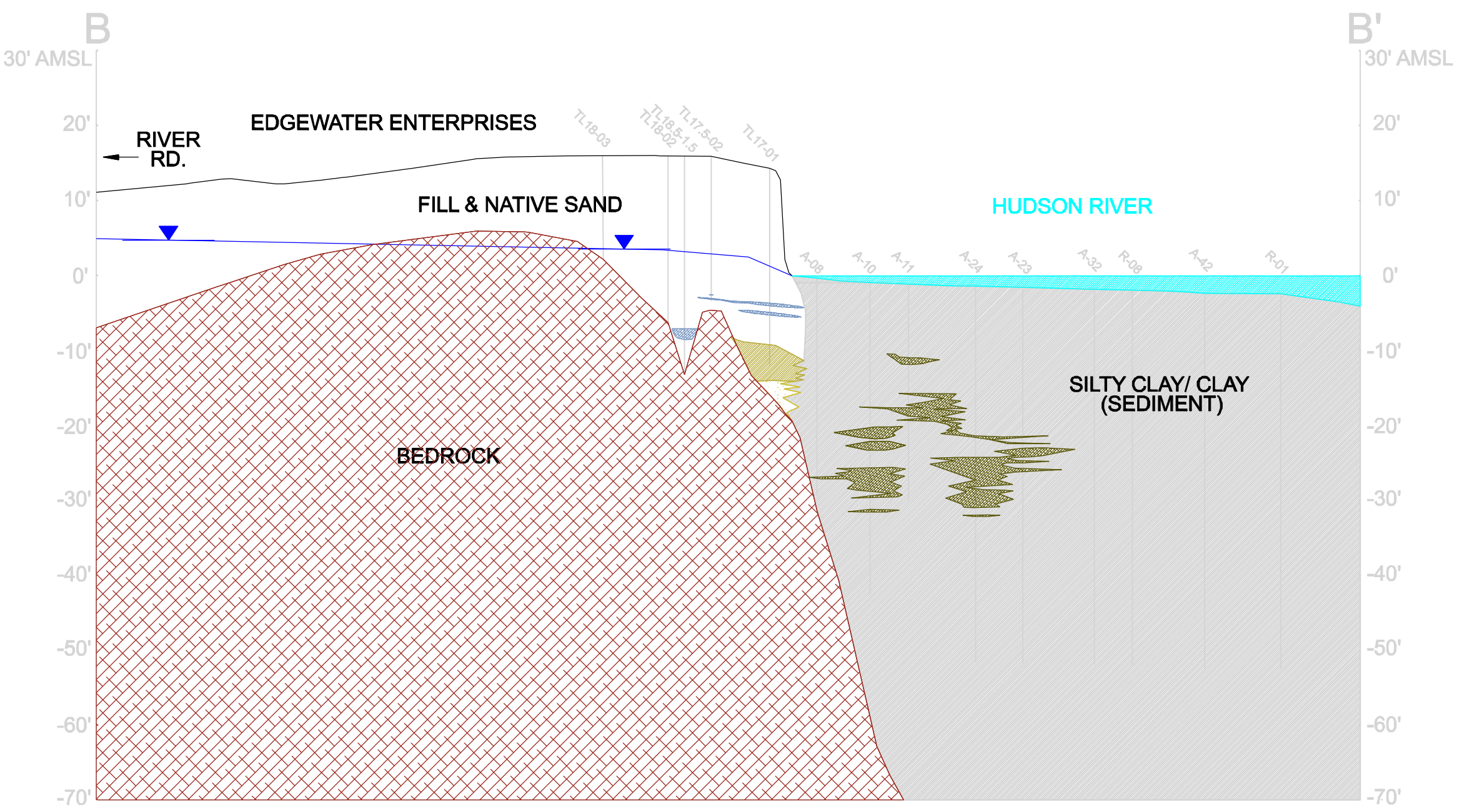
Figure 5-5 is Superseded by Figures 3-1 – 3-7 of the Final SRI Report



CROSS-SECTION LOCATIONS (PLAN VIEW)



10x VERTICAL EXAGGERATION



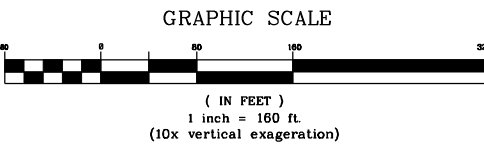
10x VERTICAL EXAGGERATION

LEGEND

- SHALLOW GROUNDWATER SURFACE
- FILL & NATIVE SAND
- SILTY-CLAY/ CLAY
- SILTY-CLAY/ CLAY (SEDIMENT)
- DEEP SAND
- BEDROCK
- OU1 TarGOST® Response (50%RE or greater)
- OU2 TarGOST® Response (6.7%RE or greater)

NOTES:  
1.) Plan view shows depiction of 2D contouring of TarGOST® results at or greater than a 50%RE response for upland soils and greater than 6.7%RE responses for OU2 sediments. Additional detail provided in Figure 3-2 of the OU2 Draft Preliminary Site Characterization Report (CH2M Hill, 2007).

Basemap Source:  
a.) Boundary and topographic survey of Block 95, Lot 1 and Block 95, Lots 1, 2, and 3 performed by Vargo Associates in September 2005 and updated as recently as June 2007.  
b.) Borough of Edgewater Tax Map - November, 1999.  
c.) Coal Tar Engineering Design Report (Environ, July 2005).  
d.) Site Investigation Report, Part 4 (Langan, May 2004) for the former Lever Bros. Property.



- | OU1 TarGOST® RESPONSES | OU2 TarGOST® RESPONSES |
|------------------------|------------------------|
| 50%RE - 100%RE         | 6.7%RE - 15%RE         |
| 100%RE - 200%RE        | 15%RE - 50%RE          |
| 200%RE - 300%RE        | 50%RE - 100%RE         |
| 300%RE - 400%RE        | 100%RE - 150%RE        |
| 400%RE - 500%RE        | > 150%RE               |
| 500%RE - 600%RE        |                        |
| 600%RE - 700%RE        |                        |
| 700%RE - 800%RE        |                        |
| 800%RE - 900%RE        |                        |
| > 900%RE               |                        |



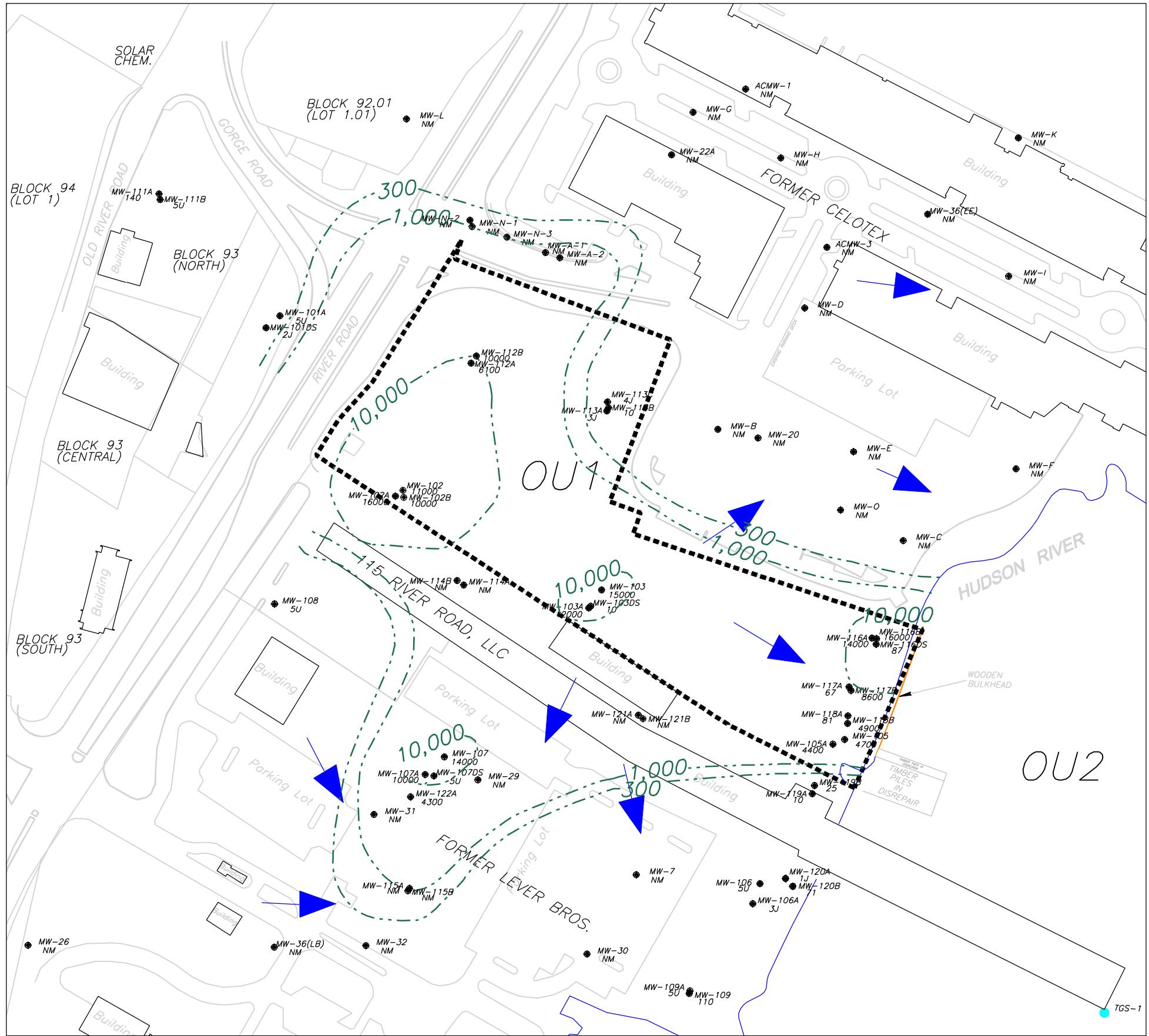
CROSS-SECTIONS  
SHOWING COAL TAR DISTRIBUTION AT OU1 & OU2  
BASED ON TarGOST®

Quanta Resources Superfund Site  
Operable Unit 1  
Edgewater, New Jersey

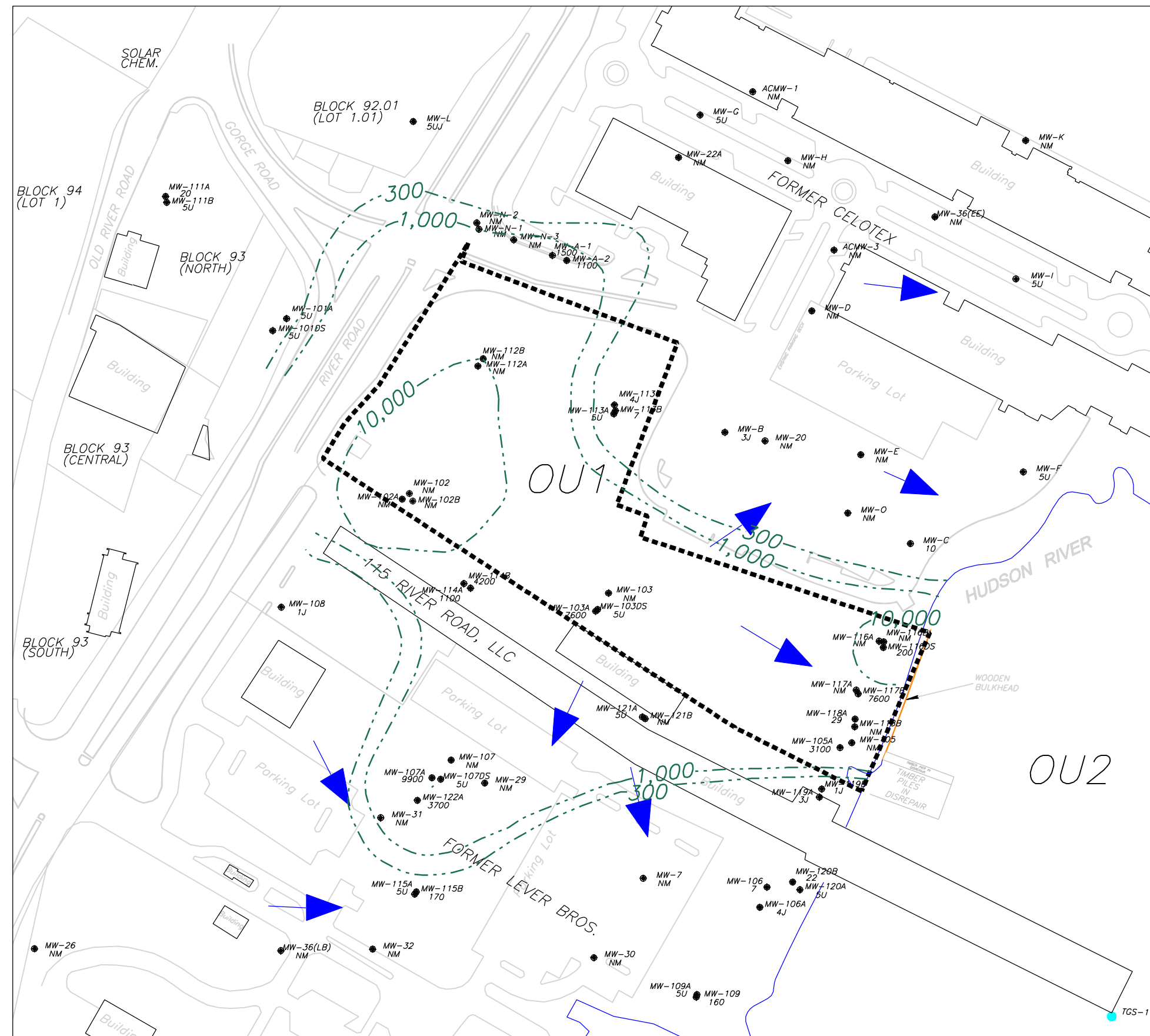
June 26, 2008

FIGURE 5-5

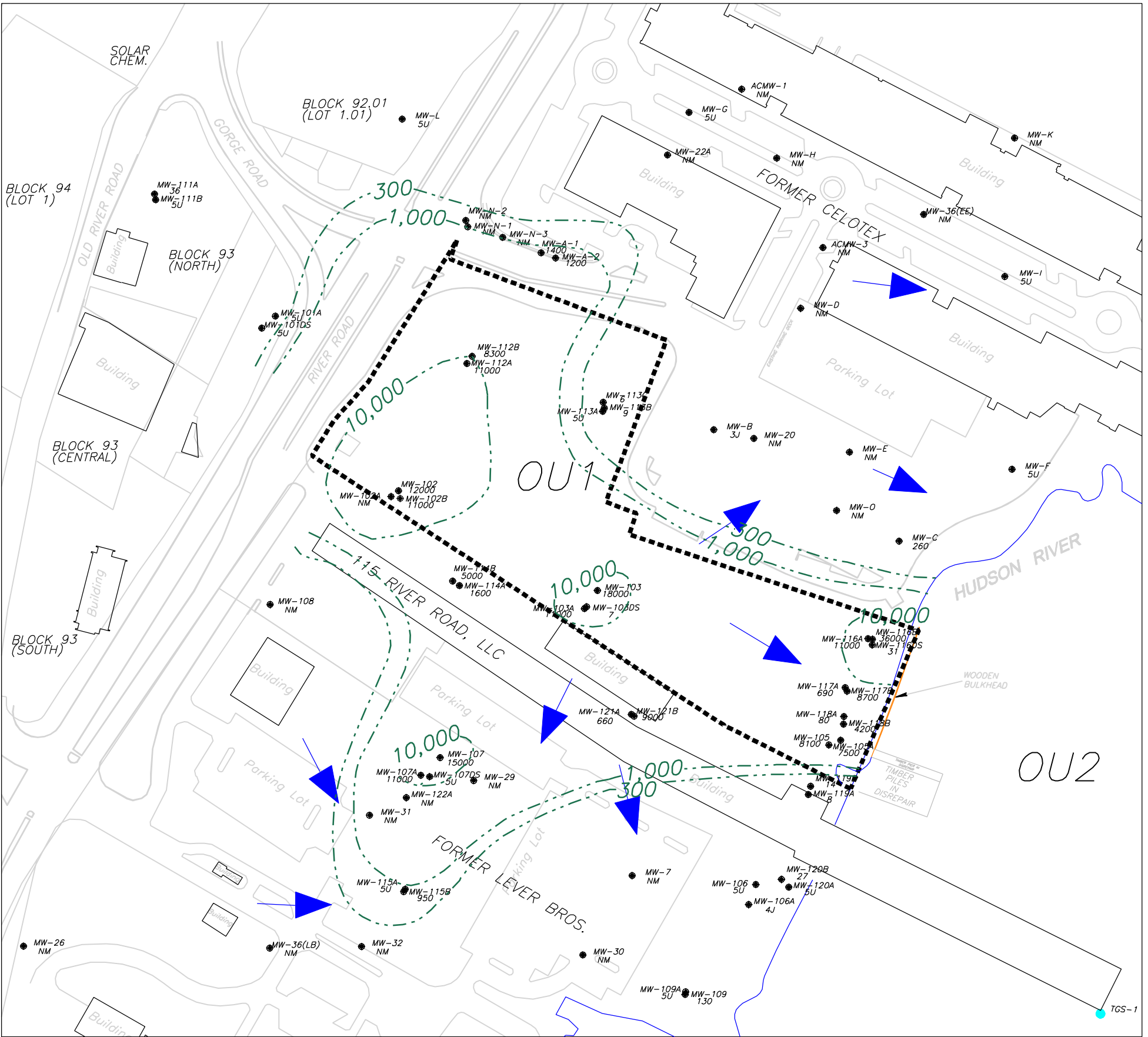




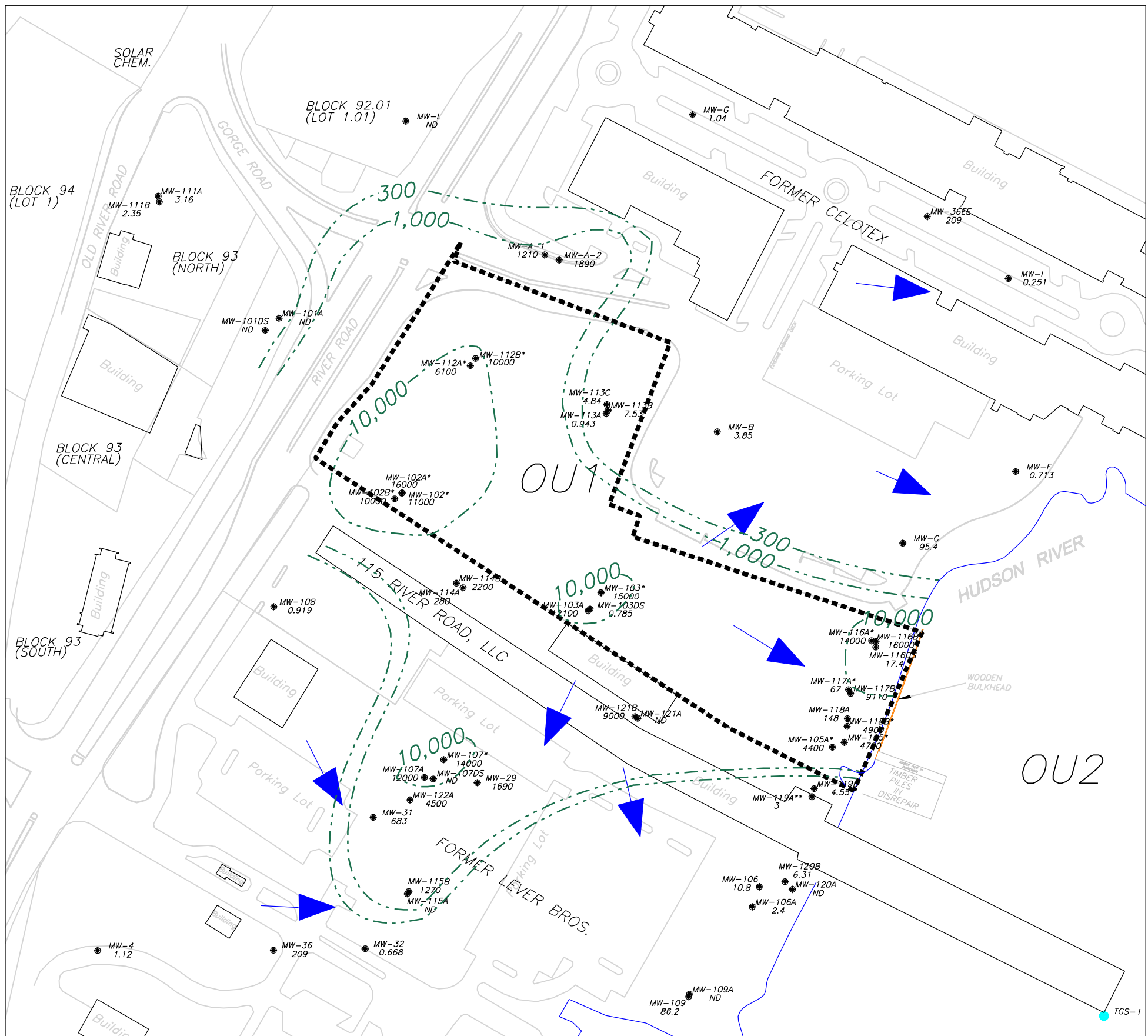
DECEMBER 2005



MAY 2006



FEBRUARY-MARCH 2006



AUGUST 2006

## LEGEND

- MW-F 107
- MONITORING WELL LOCATION WITH GROUNDWATER CONCENTRATION (ug/L)
- QUANTA PROPERTY BOUNDARY
- HUDSON RIVER SHORELINE
- GROUNDWATER ISOCONCENTRATION CONTOUR (ug/L)
- APPROXIMATE DIRECTION OF SHALLOW GROUNDWATER FLOW (OCT. 2006)

## NOTES:

1. Naphthalene Groundwater Screening Criteria:

NU Class IIA Groundwater Quality Criteria	300 ug/L
USEPA Region 9 Tap Water PRG	6.2 ug/L

2. ND = not detected

3. Concentration contours were developed initially using kriging and the software Surfer 8.0 @. Computer generated contours were subsequently adjusted by hand. The highest concentration between colocated wells was used in contouring.

4. Block 93 North consists of Lot 1, Lot 2 (north portion), Lot 3, and Lot 3.04. Block 93 Central consists of Lot 2 (south portion) and Lot 1.01. Block 93 South consists of Lot 4 and 1.02.

5. Depiction of properties adjacent to OU1 does not necessarily mean that Site-related constituents have migrated there.

6. Isoconcentration contour lines were not adjusted relative to the August and October 2006 isoconcentration contour lines (these contour lines were created based on the analytical data from the most extensive sampling events in terms of lateral and vertical extent of sample locations) if wells within the extent of the contour lines were not sampled during the respective groundwater sampling event. Changes to the contour lines relative to the August and October 2006 isoconcentration contour lines were made only if dictated by the analytical data results or by review of time versus concentration plots (if analytical data was not available) for a given groundwater sampling event.

Basemap Sources:

- Boundary and topographic survey of Block 95, Lot 1 and Block 93, Lots 1, 2, and 3 performed by Vargo Associates in September 2005 and updated as recently as September 2006.
- Borough of Edgewater Tax Map - November, 1959
- Coal Tar Engineering Design Report (Environ, July 2005)
- Site Investigation Report, Part 4 (Langan, May 2004) for the former Lever Bros. Property.

0 80 ft. 160 ft.

DRAFT

GROUNDWATER ISOCONCENTRATION CONTOURS  
NAPHTHALENE (Shallow Groundwater)

Quanta Resources Superfund Site  
Operable Unit 1  
Edgewater, New Jersey

November 9, 2007

FIGURE 5-6



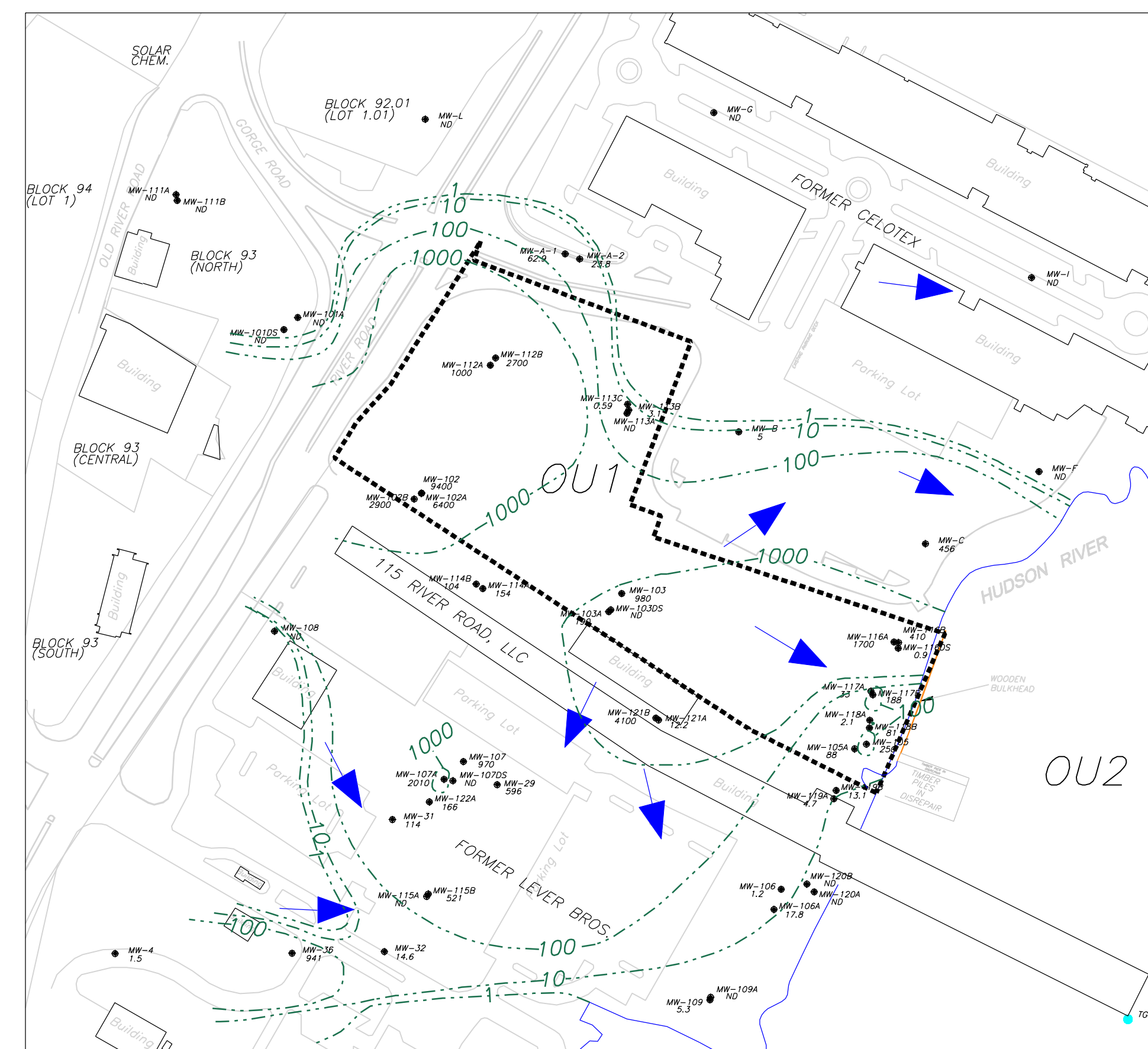
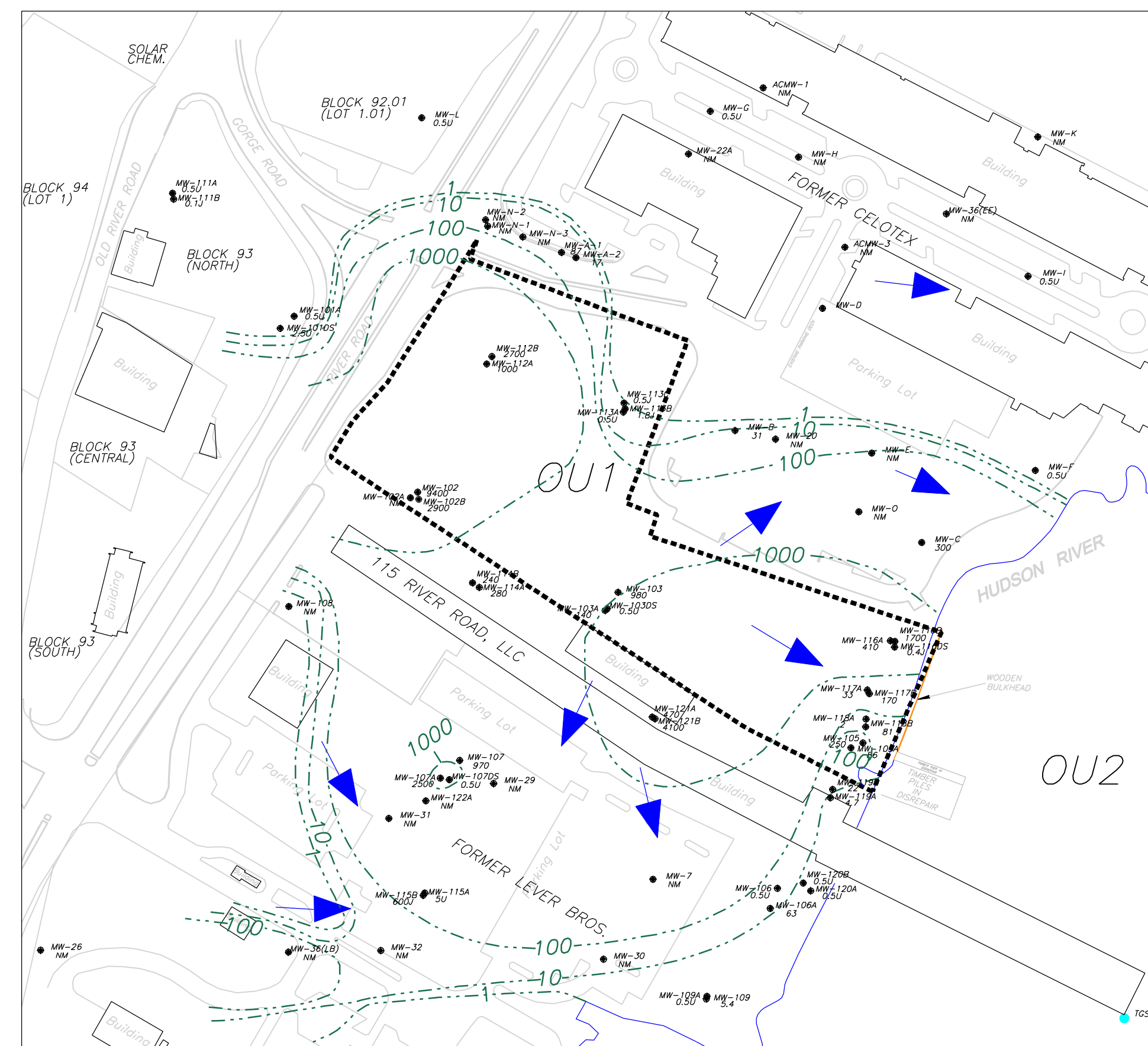
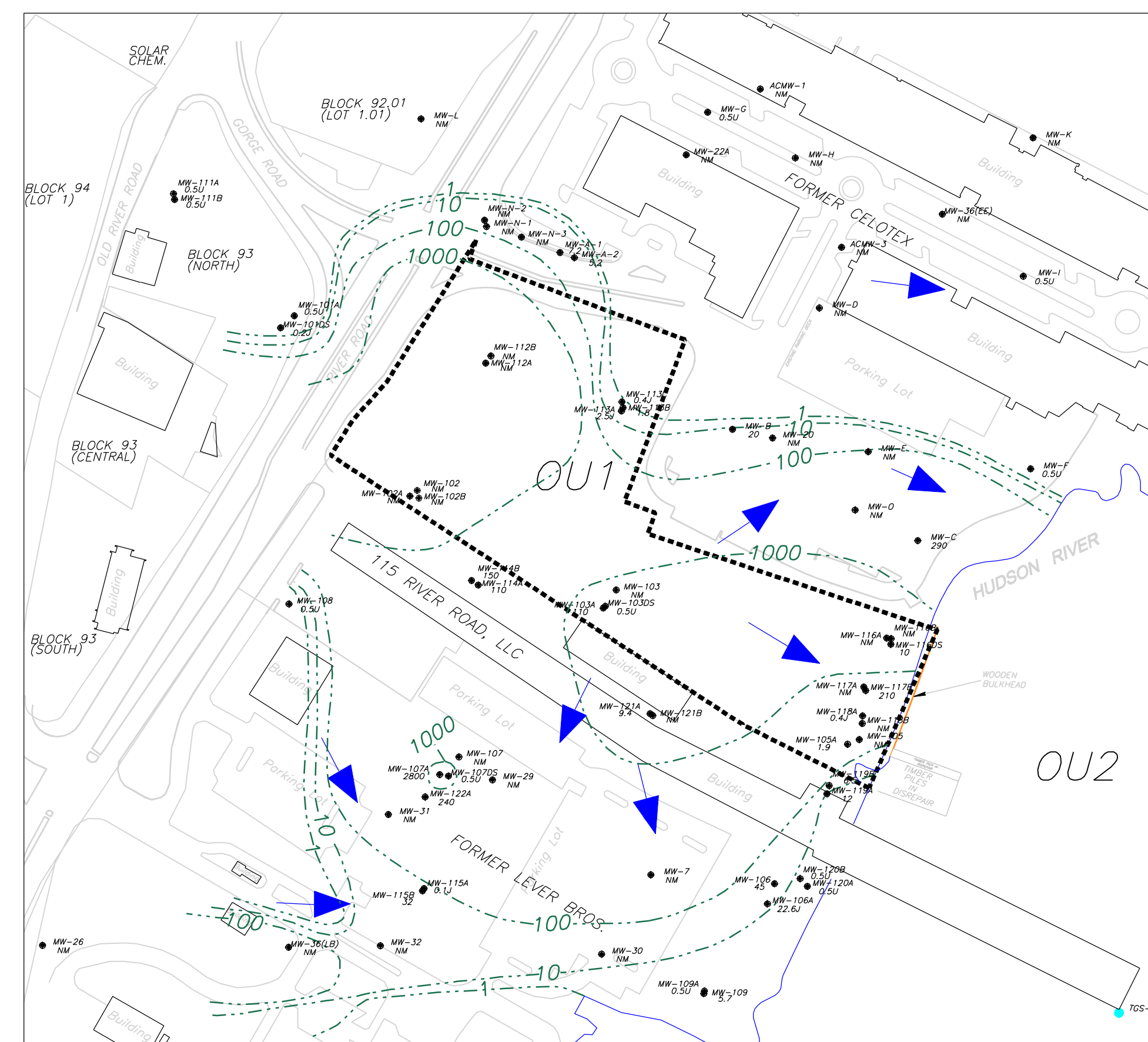
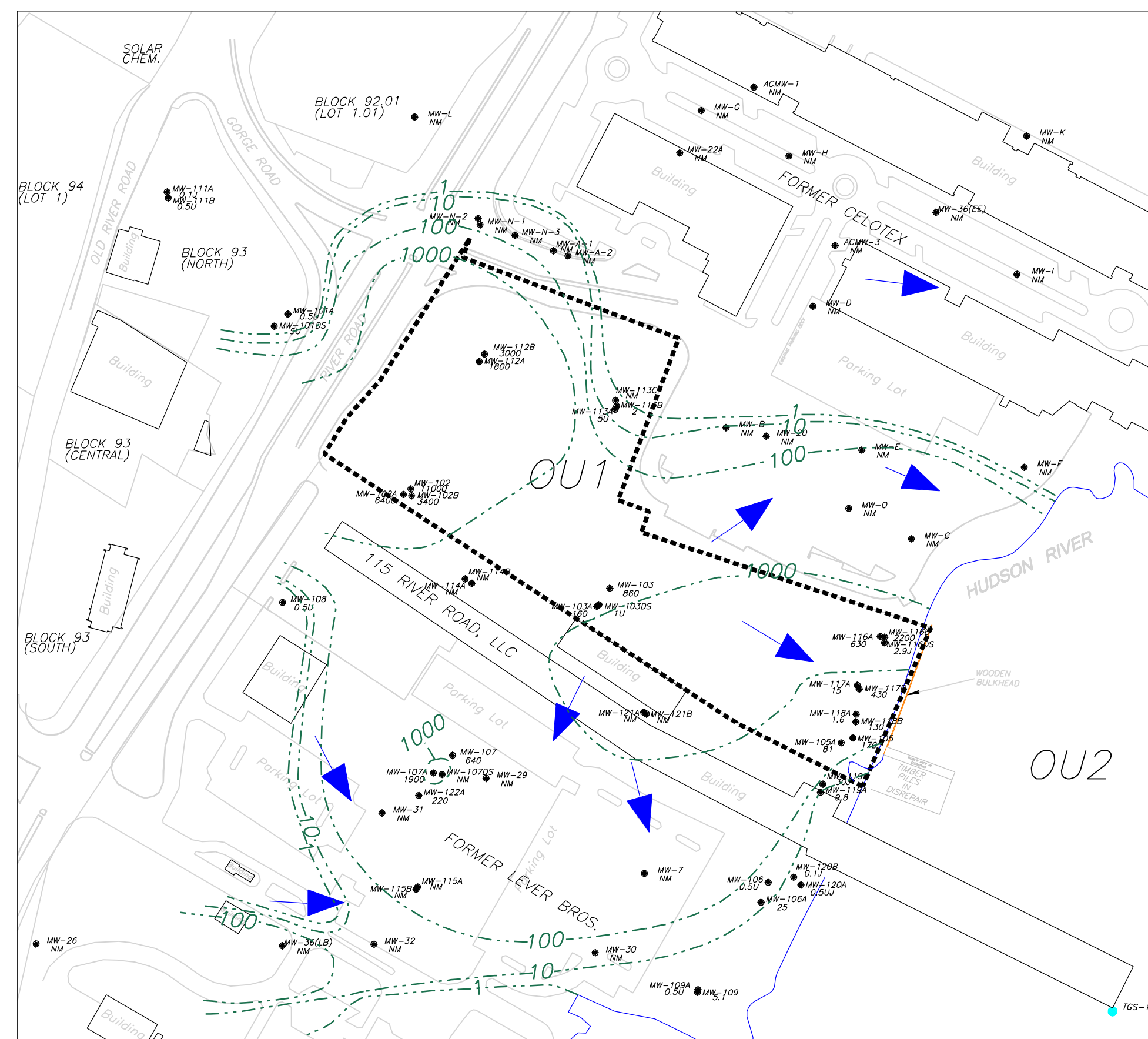
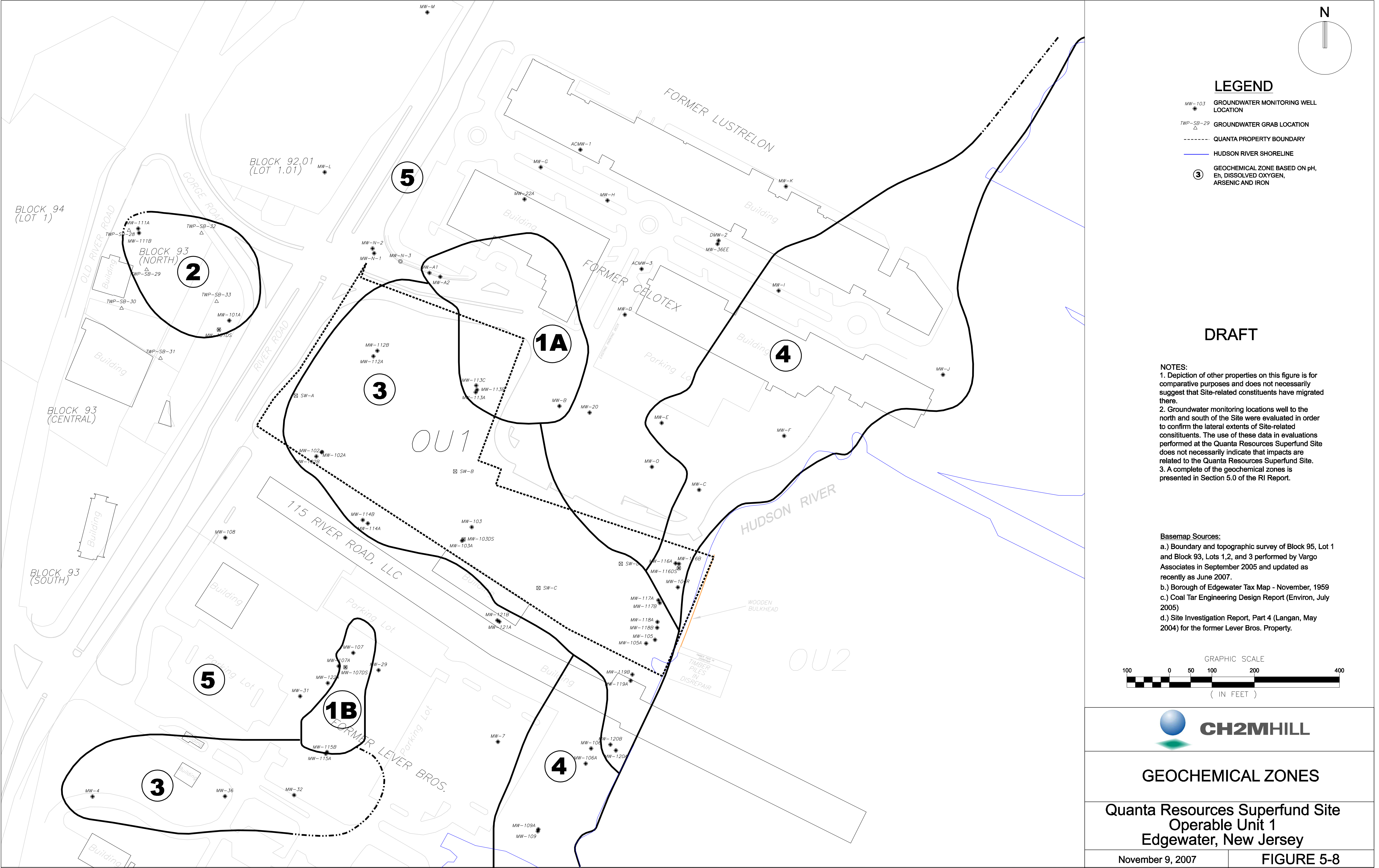
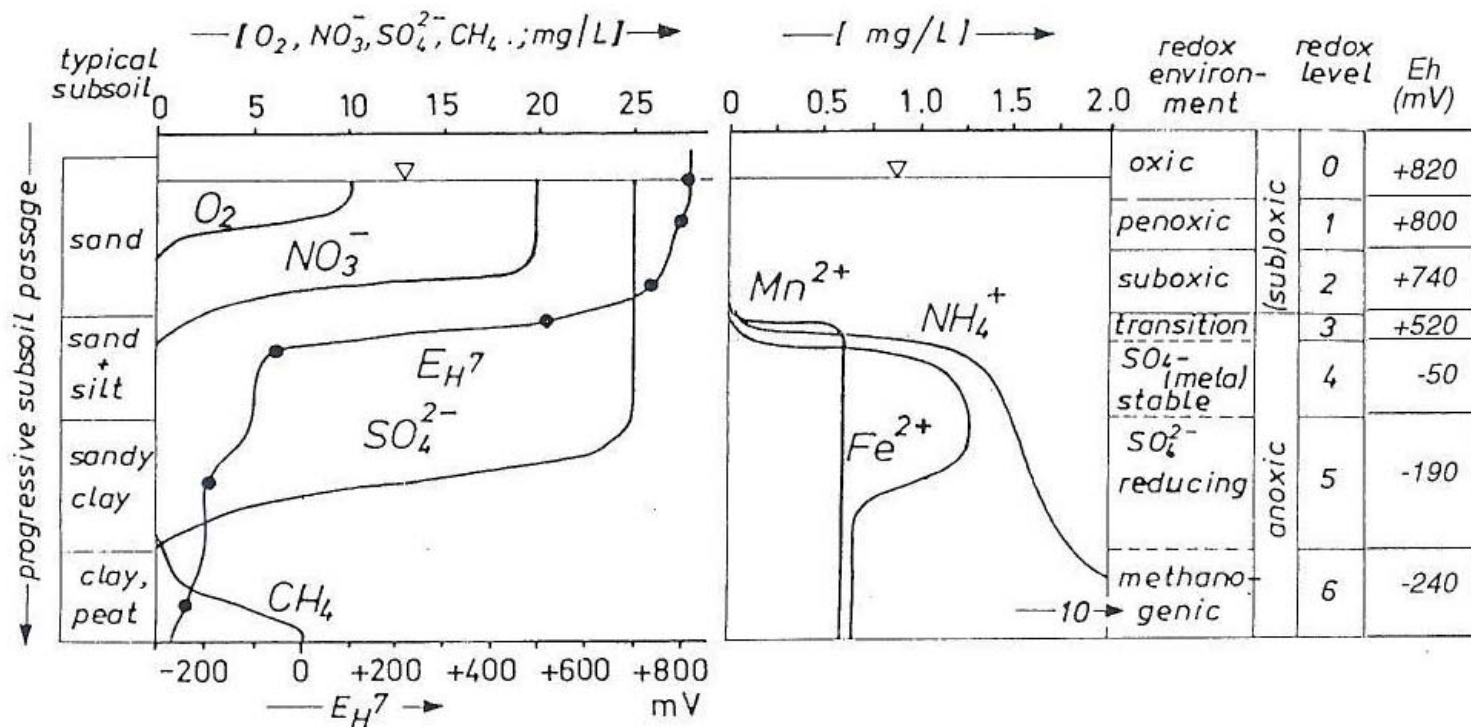




Figure 5-8 is Superseded by Figure 5-15 of the Final SRI Report





Source: Stuyfzand, 1988



## CRITERIA FOR GEOCHEMICAL DESCRIPTIONS

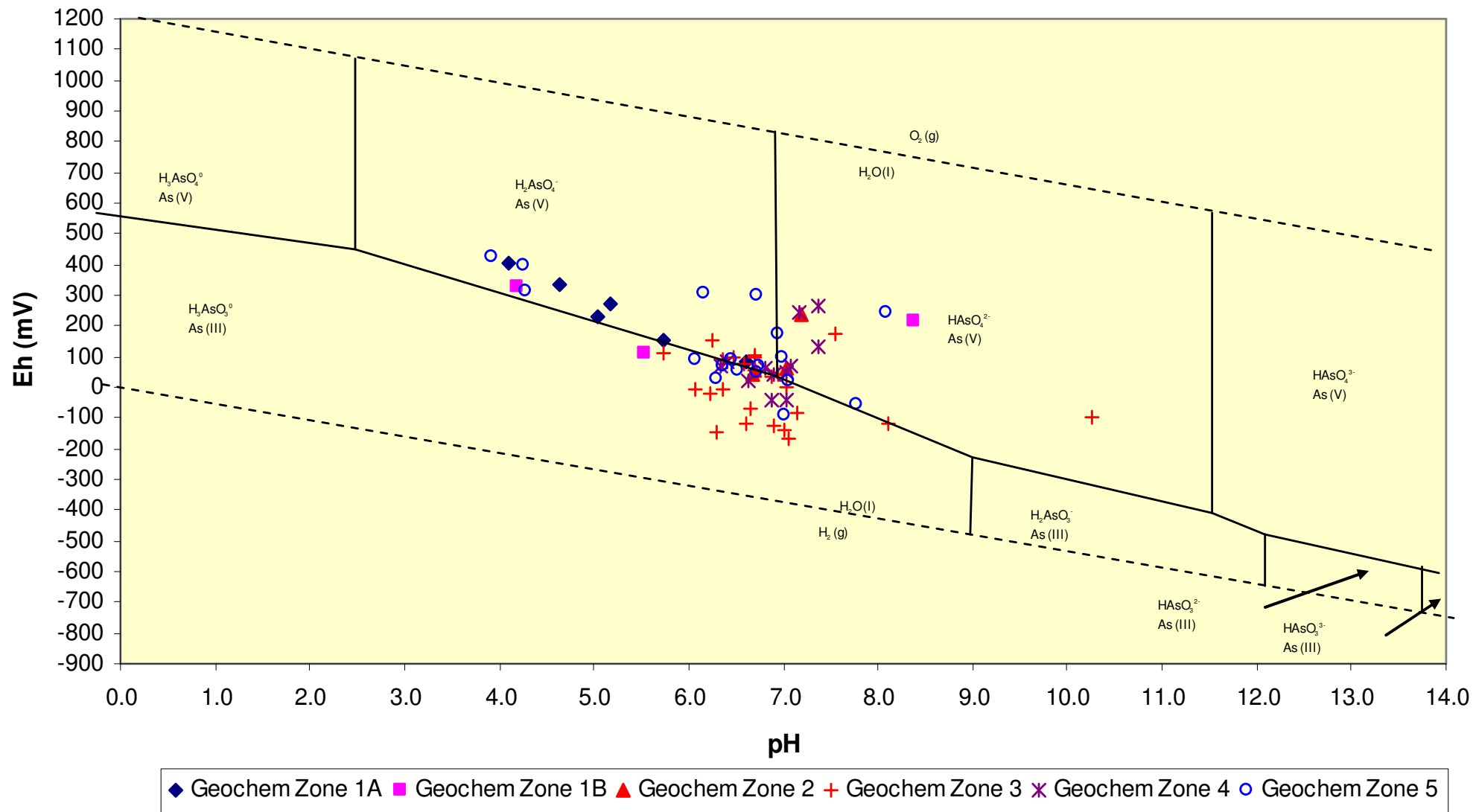
Quanta Resources Superfund Site  
Operable Unit 1  
Edgewater, New Jersey

November 5, 2007

FIGURE 5-9

306325





**Notes:**

- 1.) Eh and pH values represent the median of all values measured in wells across all RI groundwater sampling (Dec. 2005 through Oct. 2006).
- 1.) Eh was derived from ORP values by adding 199 mV (Ag Ag-Cl reference electrode was used during field data collection)
- 2.) Arsenic speciation (modified from Rai and Zachara, 1984, as presented in Deutsch, 1997, pp 169)



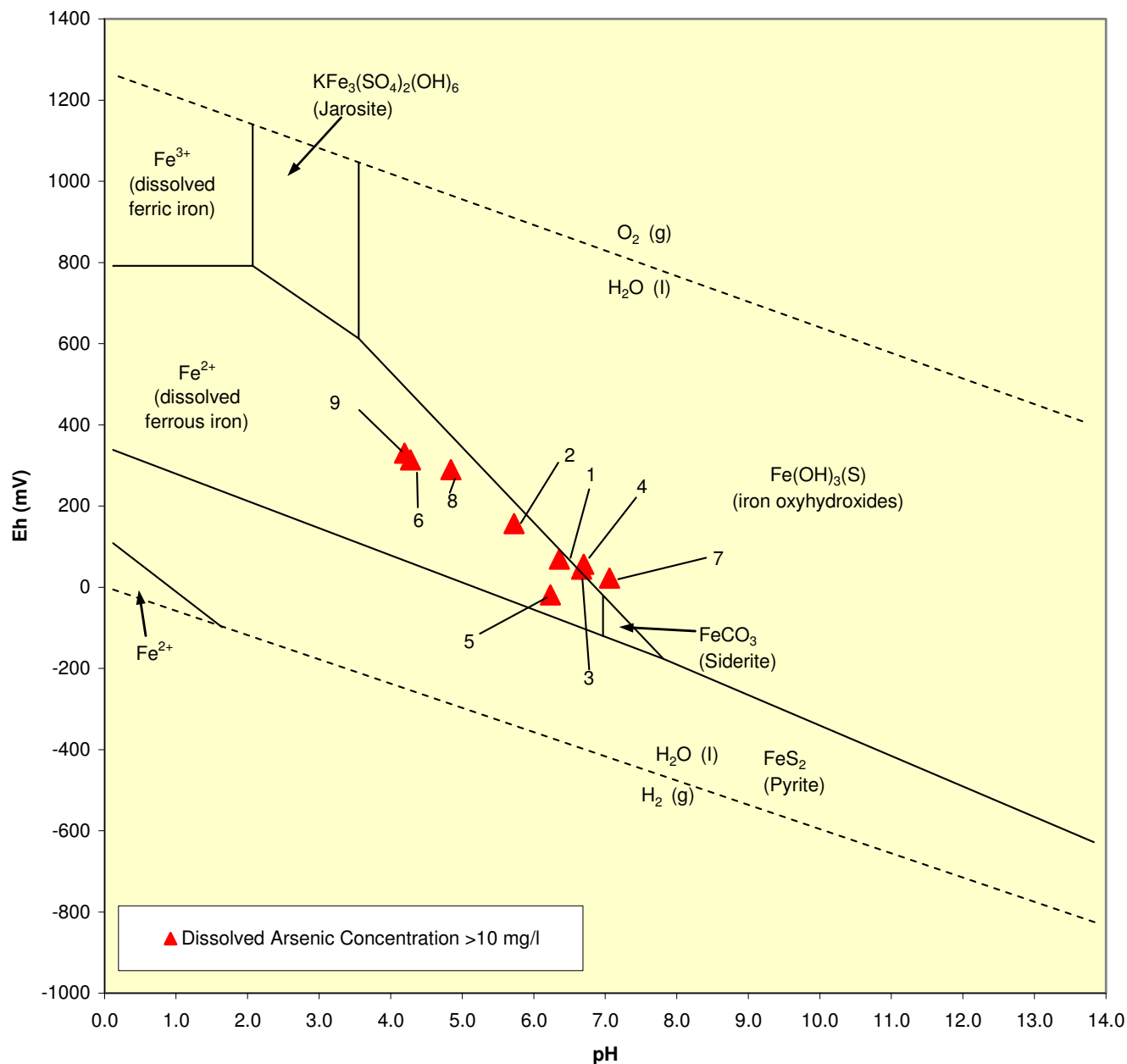
**Site-Specific Eh vs. pH and Shallow Groundwater Arsenic System**

Quanta Resources Superfund Site  
Operable Unit 1  
Edgewater, New Jersey

June 26, 2007

**FIGURE 5-10**

306326



Key:

- 1 MW-N-1
- 2 MW-A-2
- 3 MW-111B
- 4 MW-111A
- 5 MW-112B
- 6 MW-107A
- 7 MW-N-2
- 8 MW-122A
- 9 MW-107

Notes:

- 1.) Eh and pH values represent the median of all values measured in wells across all RI Groundwater Sampling (Dec. 2005 through Oct. 2006).
- 1.) Eh was derived from ORP values by adding 199 mV (Ag Ag-Cl reference electrode was used during field data collection)
- 2.) Iron system diagram (modified from Deutsch, 1997, pp 34)



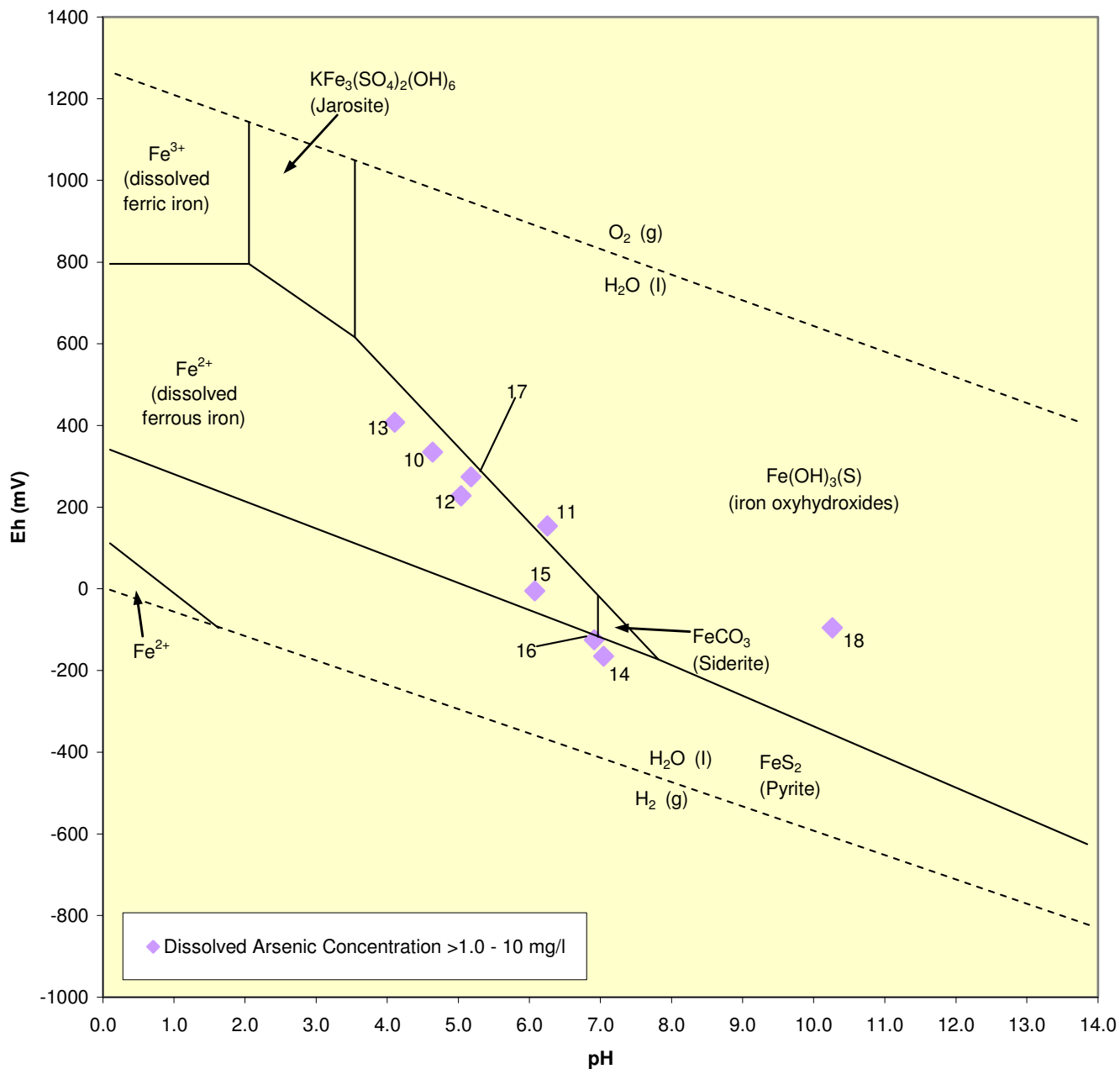
CH2MHILL

Site-Specific Eh vs. pH and Shallow Groundwater  
Partial Iron System, Dissolved As > 10 mg/L

Quanta Resources Superfund Site  
Operable Unit 1  
Edgewater, New Jersey

June 26, 2008

FIGURE 5-11a



Key:

- 10 MW-113B
- 11 MW-114B
- 12 MW-A1
- 13 MW-113C
- 14 MW-36
- 15 MW-103
- 16 MW-32
- 17 MW-B
- 18 MW-112A

Notes:

- 1.) Eh and pH values represent the median of all values measured in wells across all RI Groundwater Sampling (Dec. 2005 through Oct. 2006).
- 1.) Eh was derived from ORP values by adding 199 mV (Ag Ag-Cl reference electrode was used during field data collection)
- 2.) Iron system diagram (modified from Deutsch, 1997, pp 34)



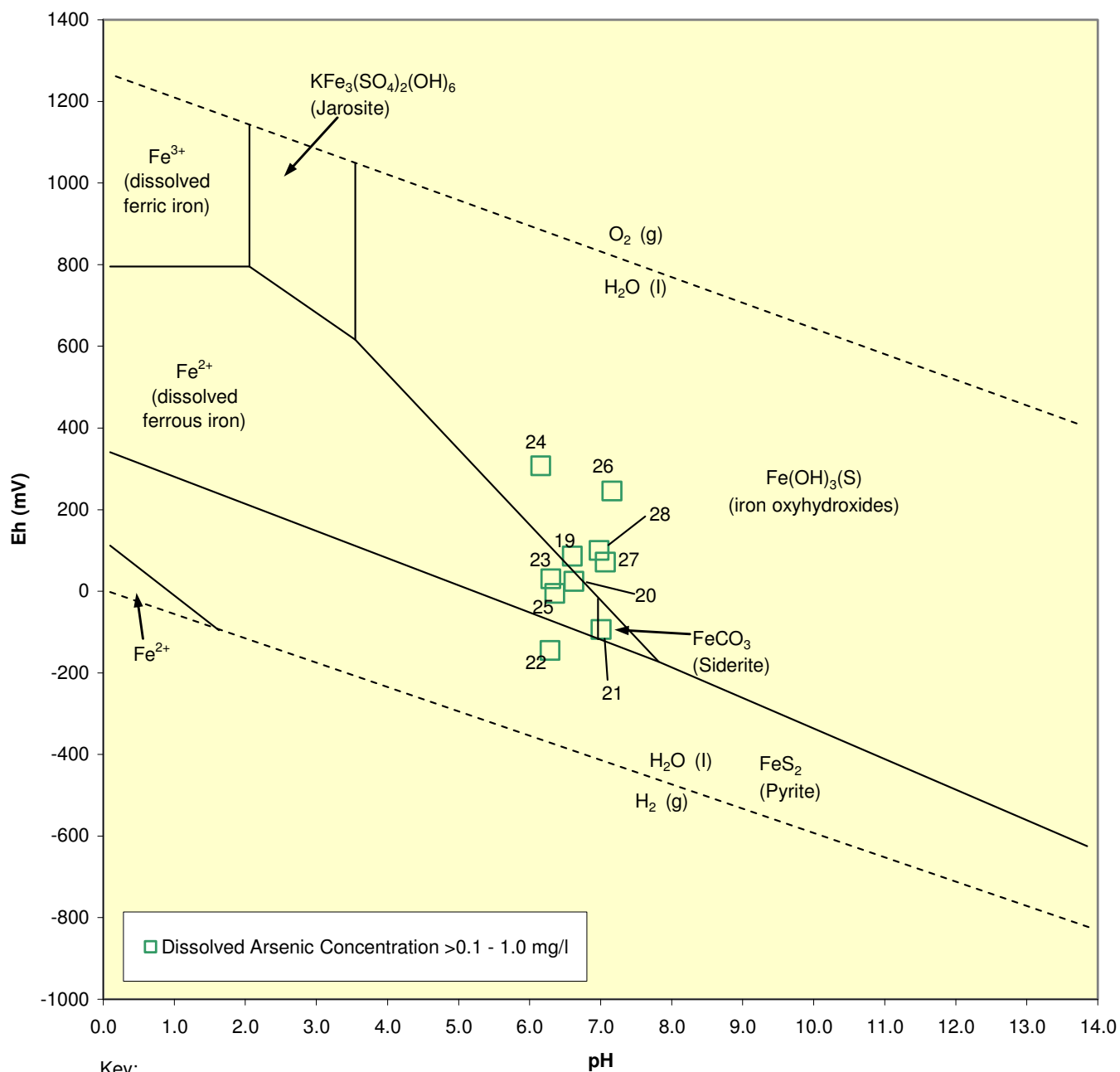
CH2MHILL

Site-Specific Eh vs. pH and Shallow Groundwater  
Partial Iron System, Dissolved As 1.0-10.0 mg/L

Quanta Resources Superfund Site  
Operable Unit 1  
Edgewater, New Jersey

June 26, 2008

FIGURE 5-11b



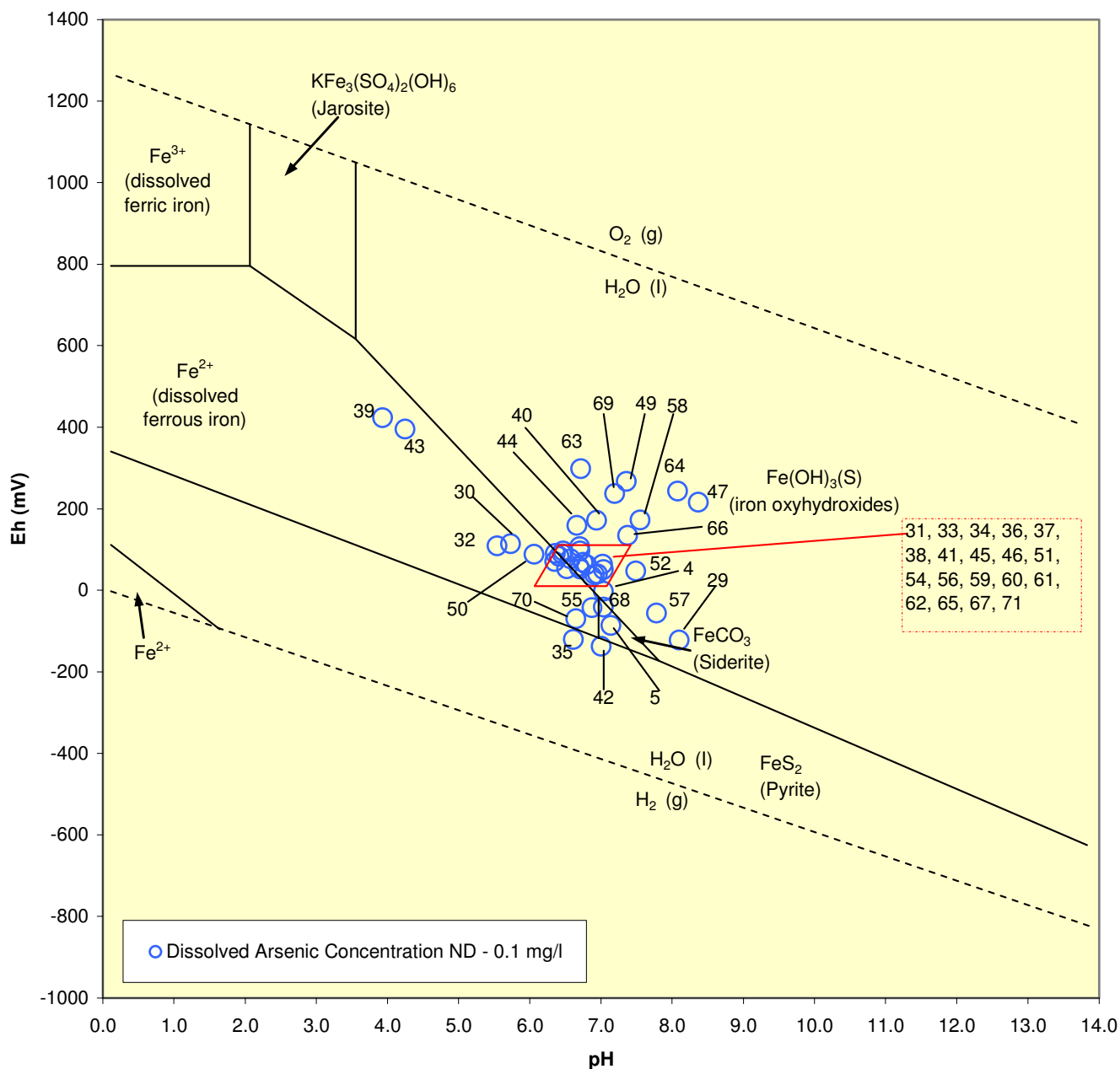
CH2MHILL

Site-Specific Eh vs. pH and Shallow Groundwater  
Partial Iron System, Dissolved As 0.1-1.0 mg/L

Quanta Resources Superfund Site  
Operable Unit 1  
Edgewater, New Jersey

June 26, 2008

FIGURE 5-11c



Notes:

- Eh and pH values represent the median of all values measured in wells across all RI Groundwater Sampling (Dec. 2005 through Oct. 2006).
- Eh was derived from ORP values by adding 199 mV (Ag Ag-Cl reference electrode was used during field data collection)
- Iron system diagram (modified from Deutsch, 1997, pp 34)



CH2MHILL

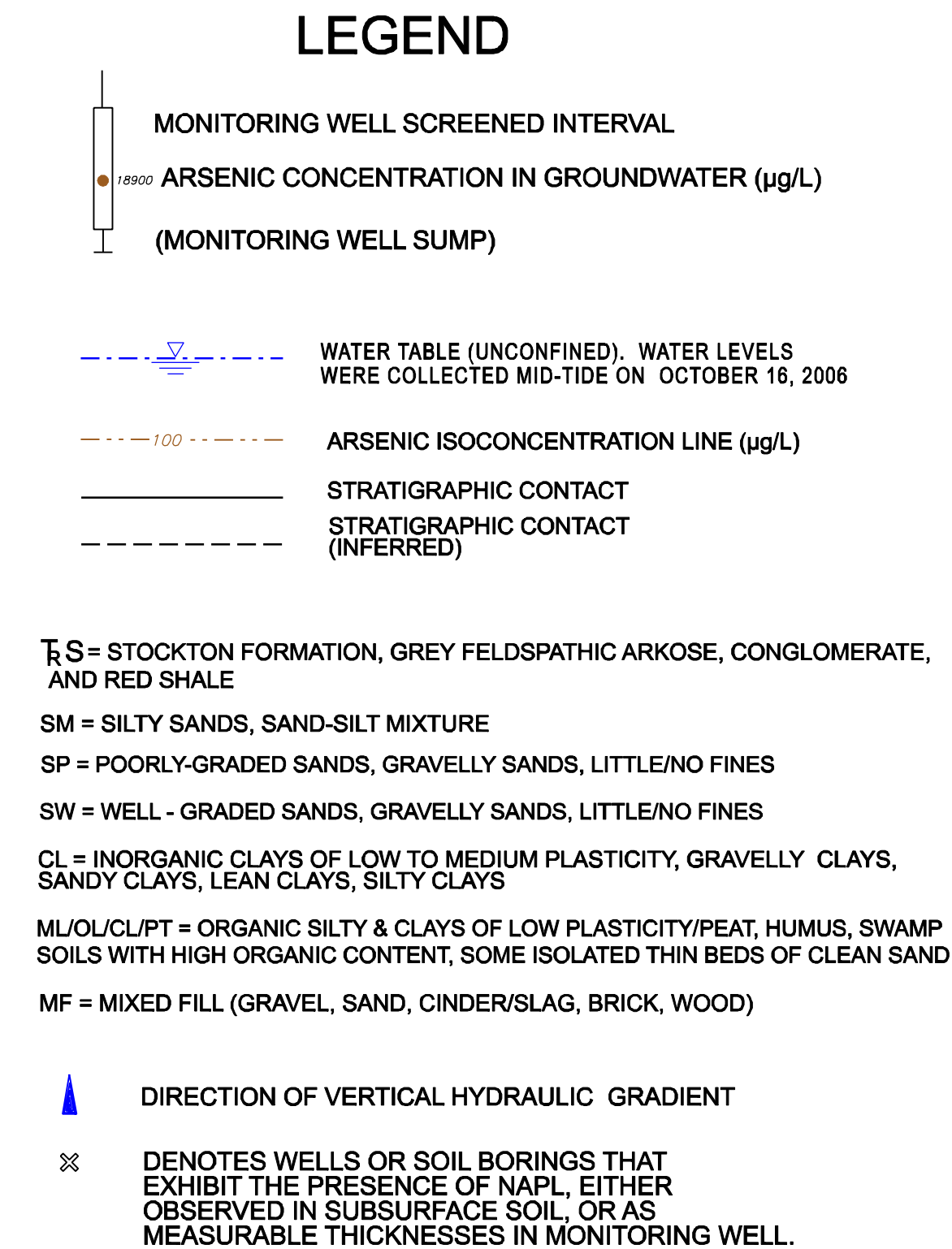
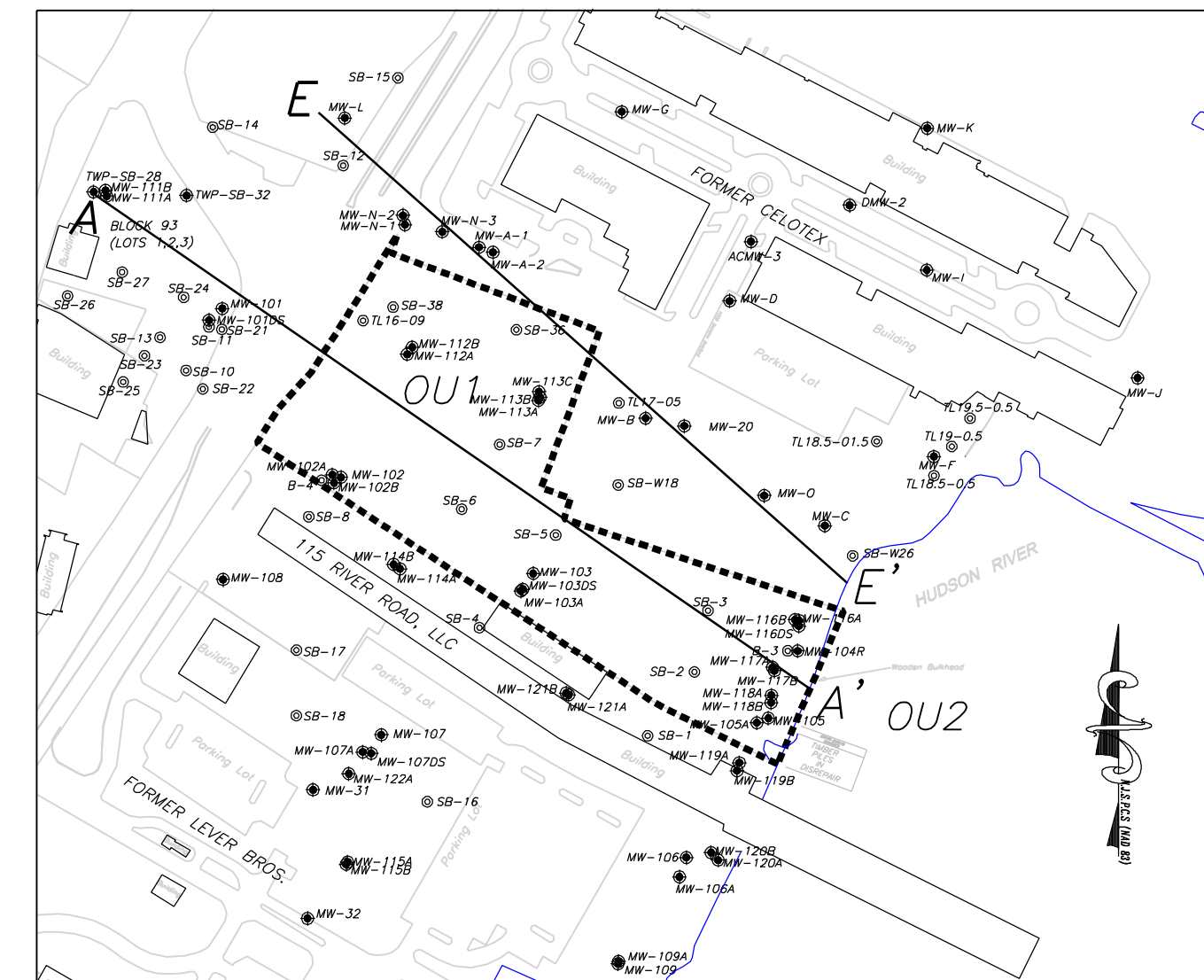
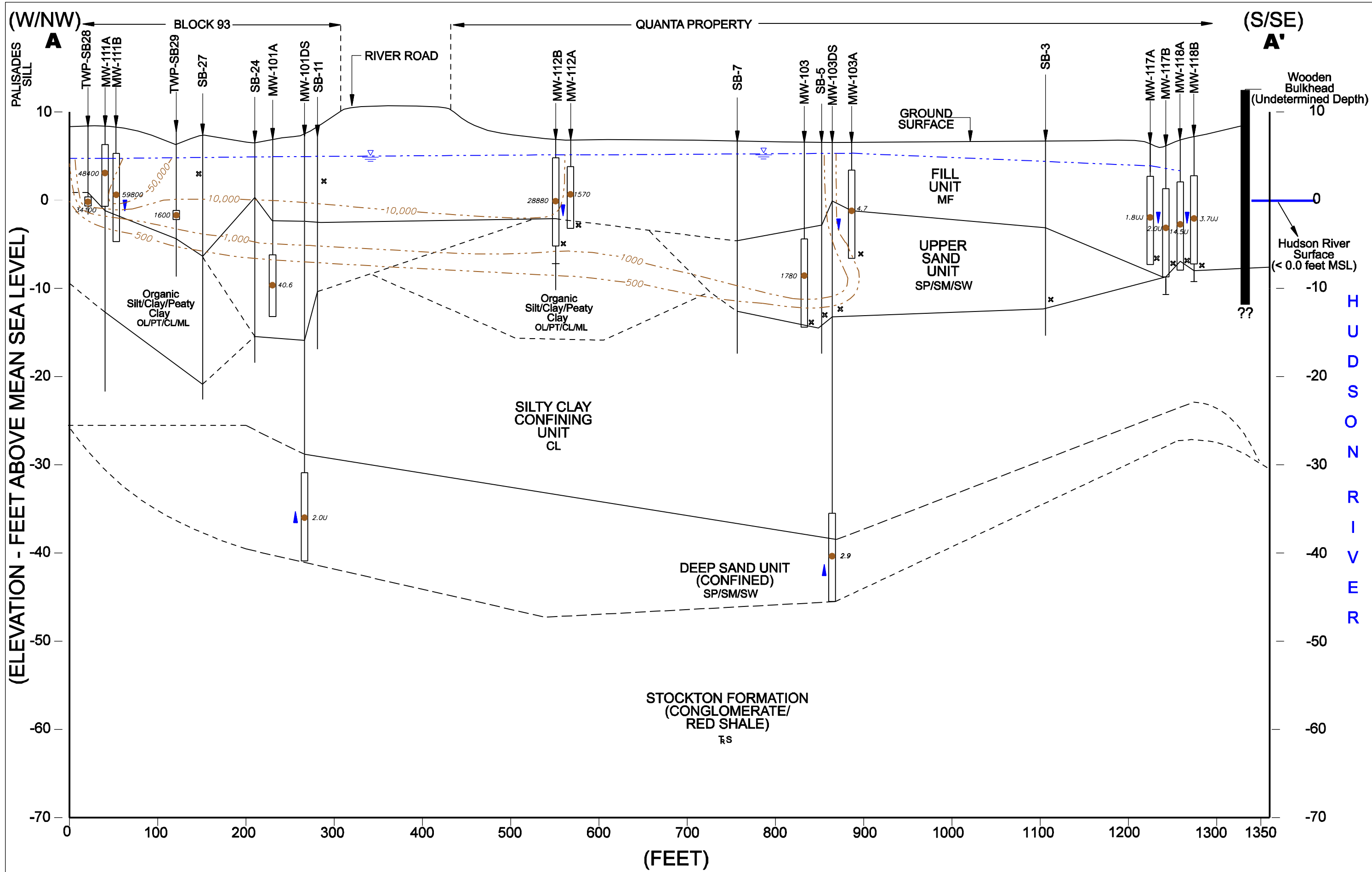
Site-Specific Eh vs. pH and Shallow Groundwater  
Partial Iron System, Dissolved As ND-0.1 mg/L

Quanta Resources Superfund Site  
Operable Unit 1  
Edgewater, New Jersey

June 26, 2008

FIGURE 5-11d

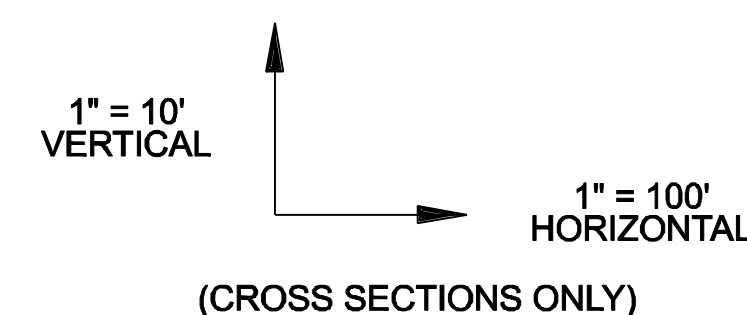




## NOTES

- DEPICTED BORINGS AND MONITORING WELLS ARE LOCATED WITHIN A MAXIMUM OF 80 FEET FROM THE TRANSECT LINES.
- CERTAIN GROUND SURFACE ELEVATIONS ARE APPROXIMATE SUCH AS RIVER ROAD. GROUND SURFACE ELEVATION AT SOIL BORING SB-W16 AND SB-W20 WERE UNAVAILABLE AND ASSUMED TO BE EQUAL TO THE GROUND SURFACE ELEVATION AT MW-C.
- GEOLOGIC DATA AND WELL CONSTRUCTION DETAILS FOR MW-20 WERE UNAVAILABLE. STRATIGRAPHIC CONTACTS WERE INFERRED AND WELL CONSTRUCTION WAS ASSUMED TO CONSIST OF A 10-FOOT LONG WELL SCREEN WITH THE BOTTOM OF THE SCREEN AT THE BOTTOM OF THE MONITORING WELL (TOTAL WELL DEPTH WAS MEASURED DURING THE OCTOBER 2006 SI GROUNDWATER SAMPLING EVENT).
- ARSENIC GROUNDWATER SCREENING CRITERIA:

NU Class 1IA Groundwater Quality Criteria	3 µg/L
USEPA Region 9 Tap Water PRG	0.045 µg/L
- THE TOP OF THE SILTY CLAY CONFINING UNIT WAS USED AS THE BOUNDARY TO VERTICALLY DELINEATE ARSENIC.



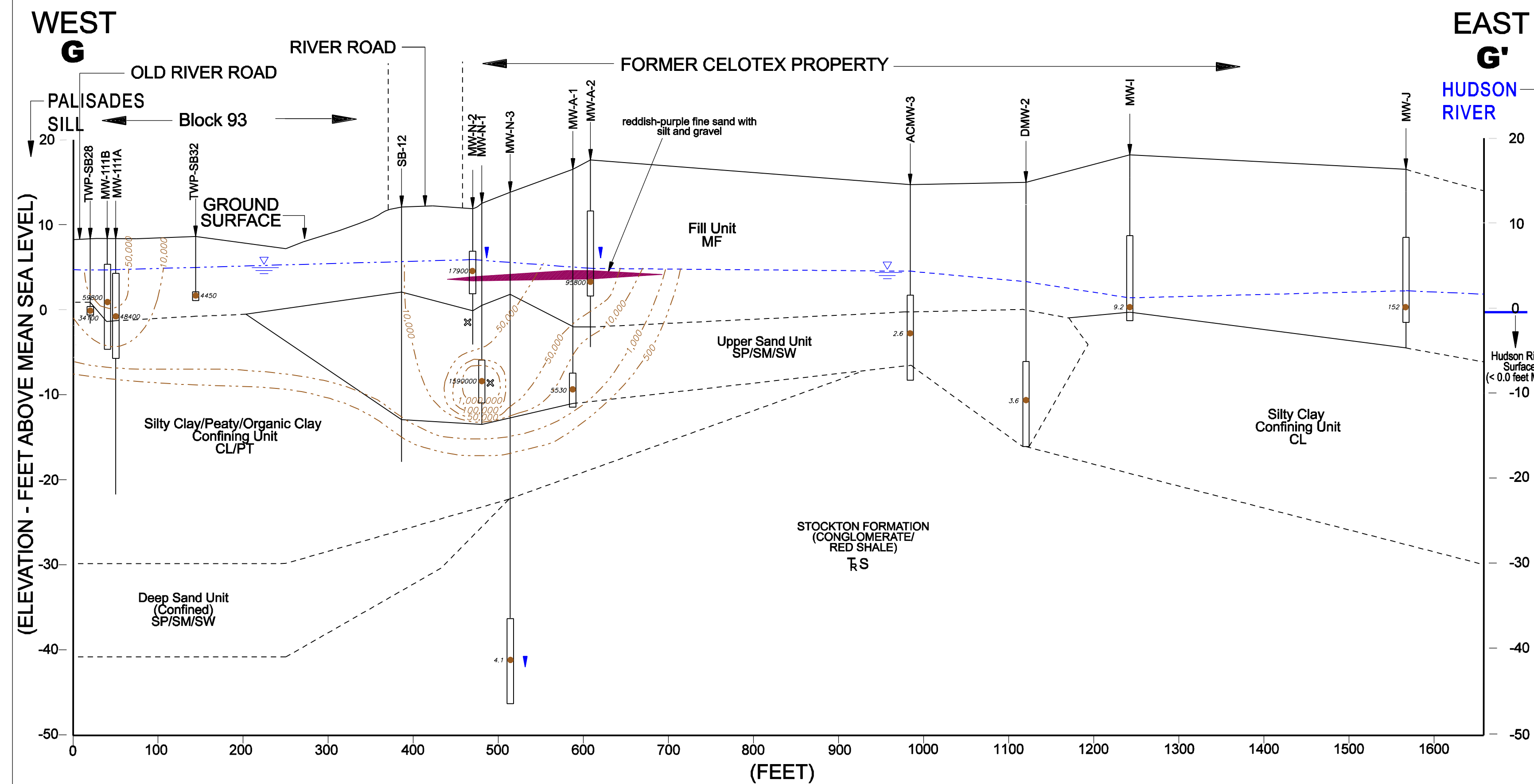
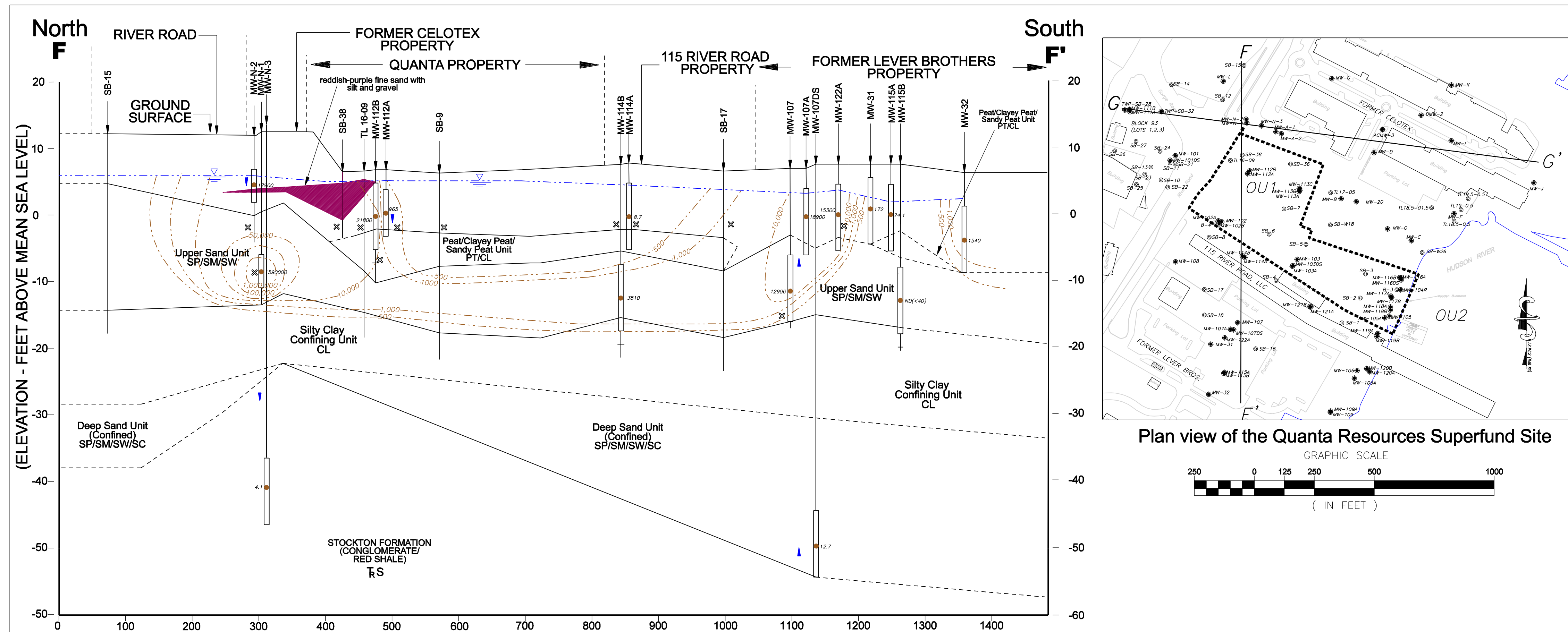
Geologic Cross Sections A to A' and E to E' & Arsenic in Groundwater Isoconcentration Lines

Quanta Resources Superfund Site  
Operable Unit 1  
Edgewater, New Jersey

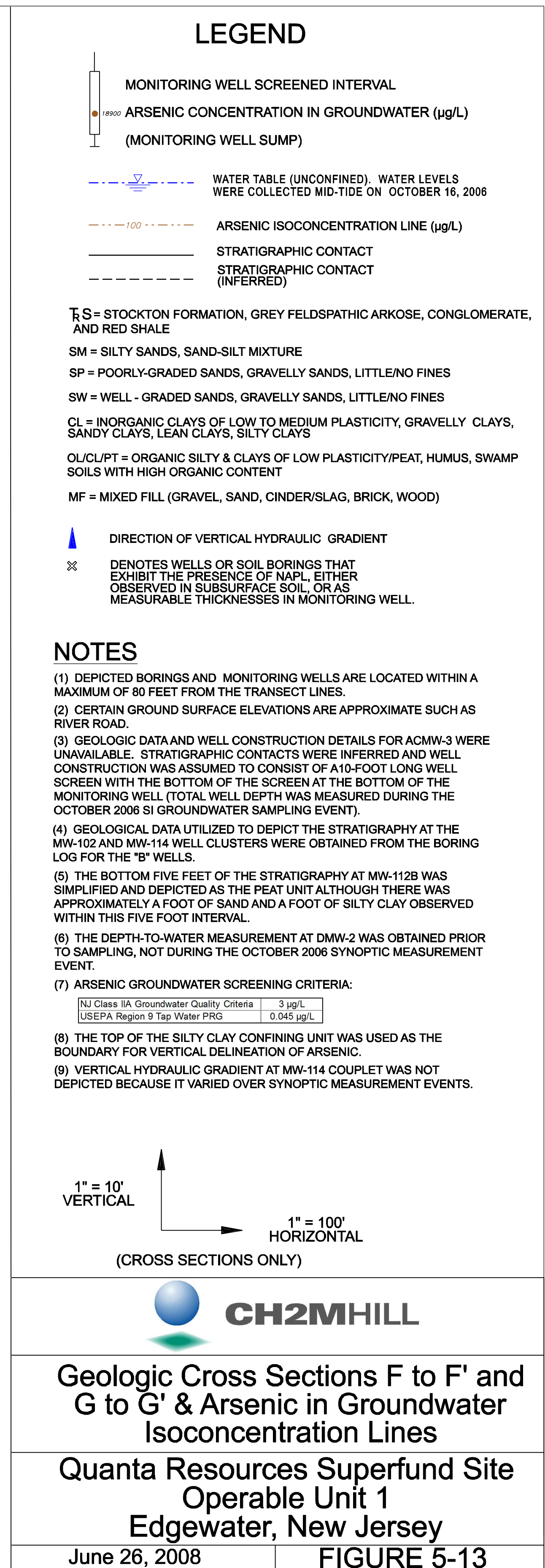
June 26, 2008

FIGURE 5-12

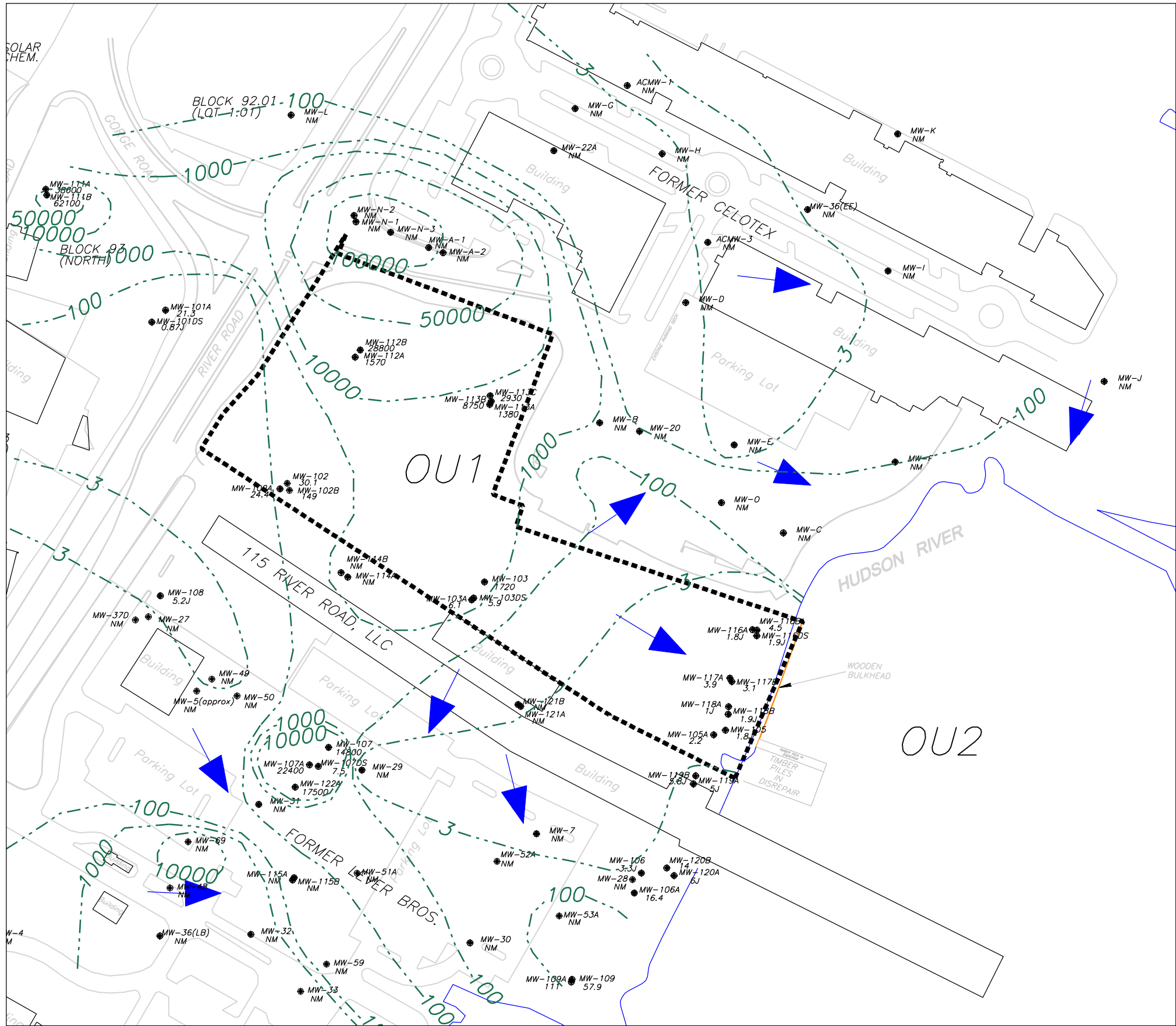




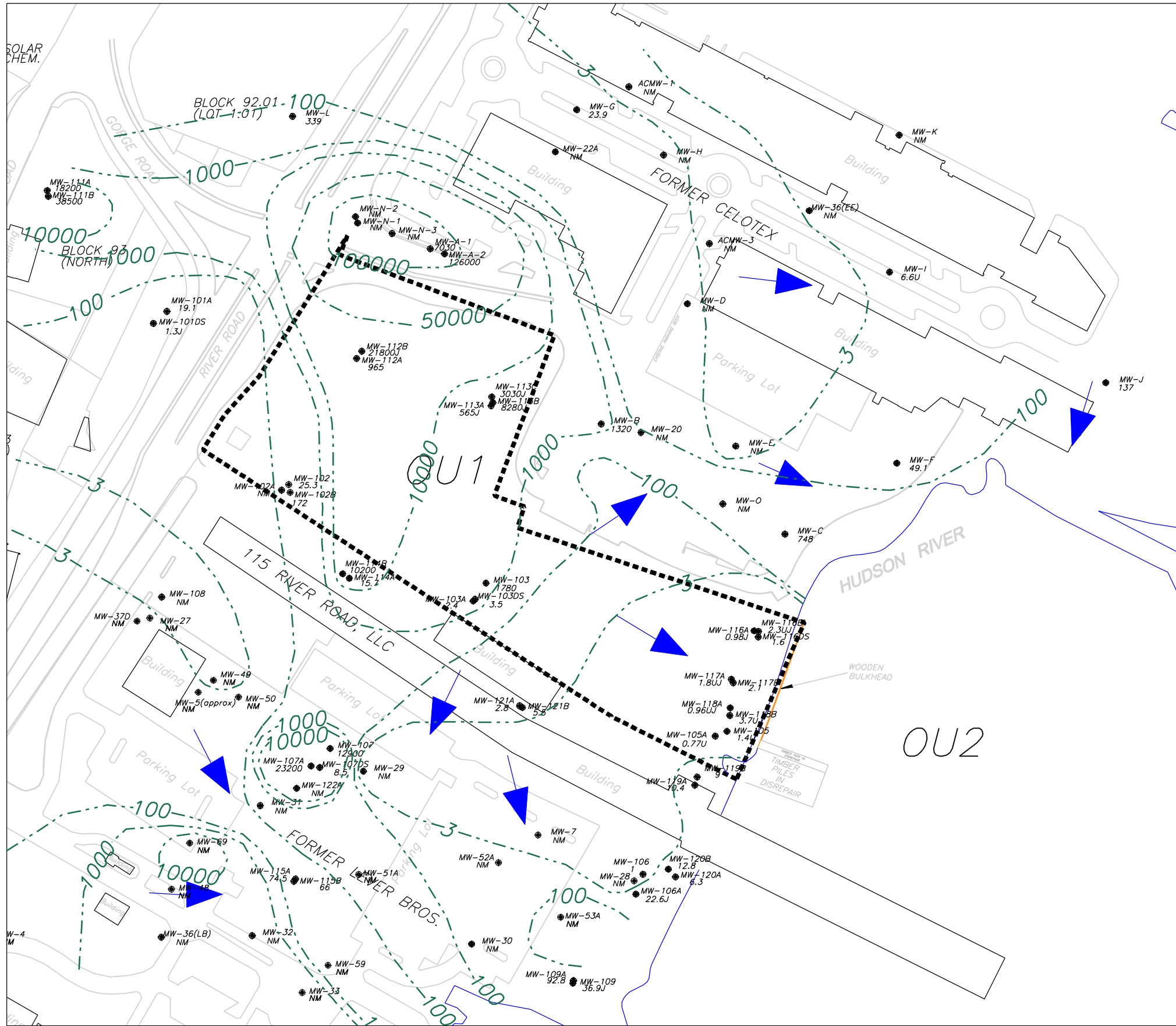
sectionf-f'-g-g'.dgn



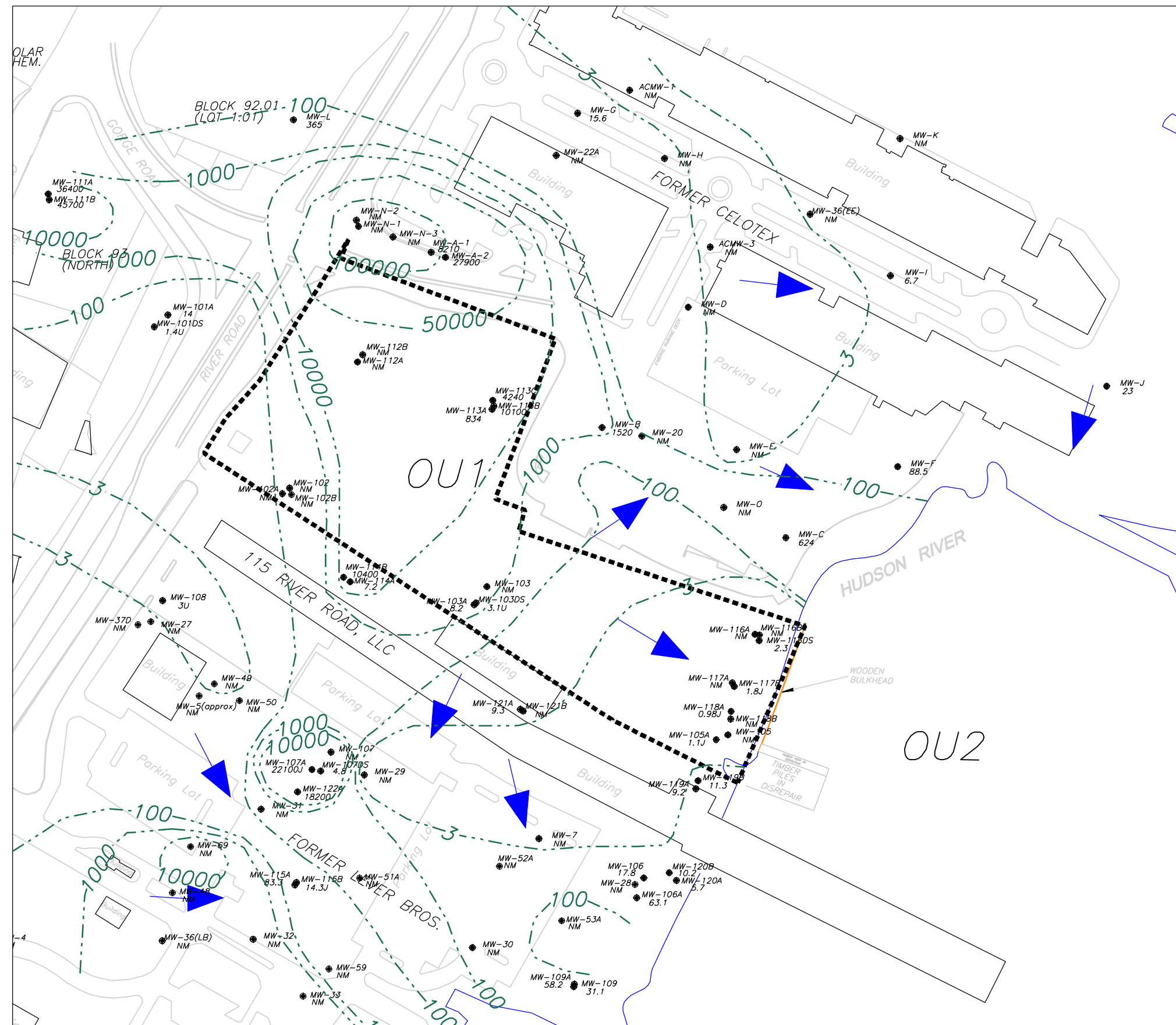




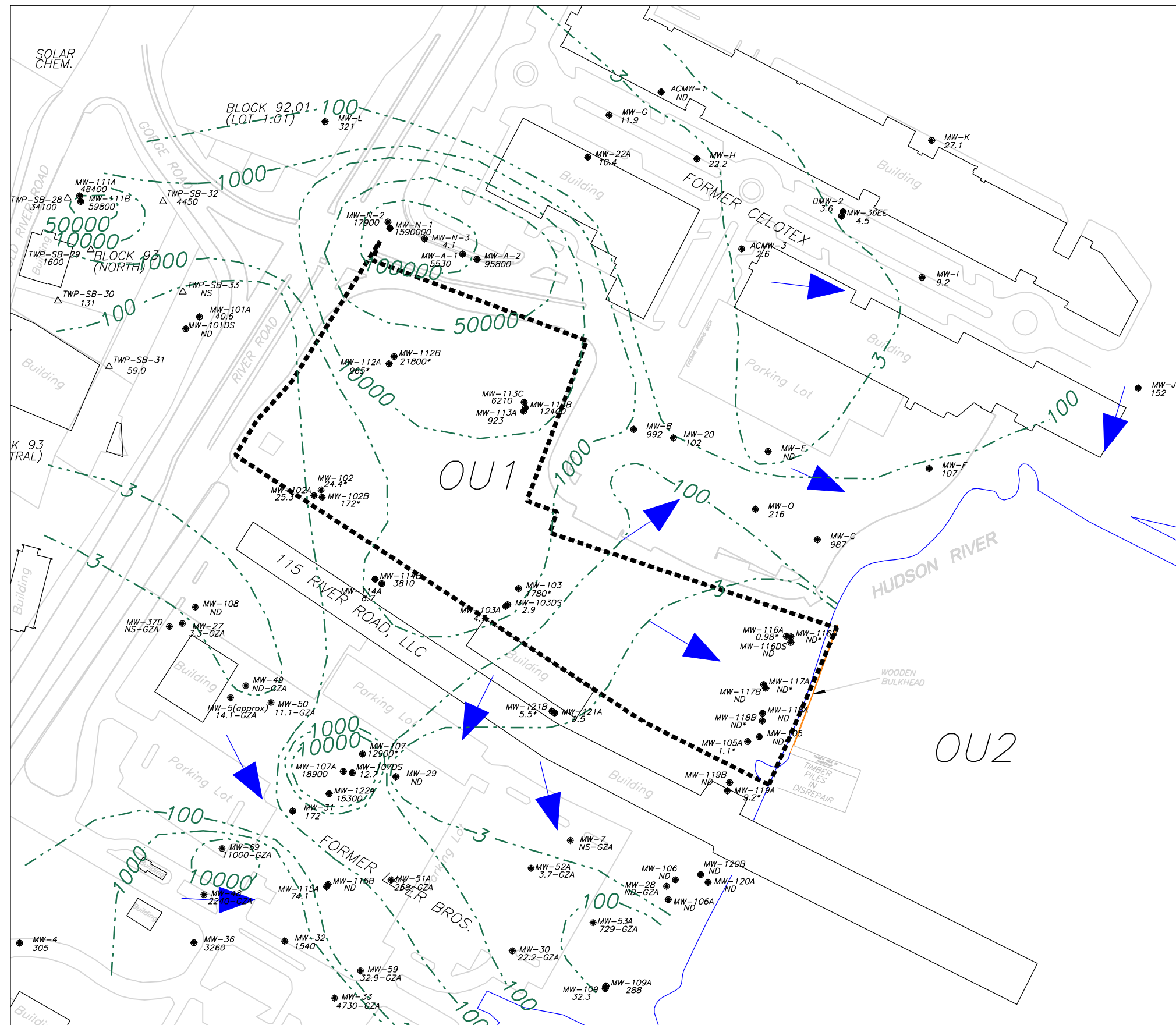
DECEMBER 2005



FEBRUARY-MARCH 2006



MAY 2006



AUGUST/OCTOBER 2006

## LEGEND

MONITORING WELL LOCATION  
WITH GROUNDWATER  
CONCENTRATION (ug/L)

MONITORING WELL SAMPLED  
BY GZA IN JUNE 2007  
(AUGUST/OCTOBER 2006  
FIGURE ONLY)

QUANTA PROPERTY  
BOUNDARY

HUDSON RIVER SHORELINE

GROUNDWATER  
ISOCONCENTRATION  
CONTOUR (ug/L)

APPROXIMATE DIRECTION OF  
SHALLOW GROUNDWATER  
FLOW (OCT. 2006)

### NOTES:

- Arsenic Groundwater Screening Criteria:  
NJ Class IIA Groundwater Quality Criteria 3 ug/L  
USEPA Region 9 Tap Water PRG 0.045 ug/L
- ND = not detected
- Concentration contours were developed initially using kriging and the software Surfer 8.0 ®. Computer generated contours were subsequently adjusted by hand. The highest concentration between collocated wells was used in contouring.
- Block 93 North consists of Lot 1, Lot 2 (north portion), Lot 3, and Lot 3.04. Block 93 Central consists of Lot 2 (south portion) and Lot 1.01. Block 93 South consists of Lot 4 and 1.02.
- Depiction of properties adjacent to OU1 does not necessarily mean that Site-related constituents have migrated there.
- Isoconcentration contour lines were not adjusted relative to the August and October 2006 isoconcentration contour lines (these contour lines were created based on the analytical data from the most extensive sampling events in terms of lateral and vertical extent of sample locations) if wells within the extent of the contour lines were not sampled during the respective groundwater sampling event. Changes to the contour lines relative to the August and October 2006 isoconcentration contour lines were made only if dictated by the analytical data results or by review of time versus concentration plots (if analytical data was not available) for a given groundwater sampling event.
- Arsenic data from groundwater grab samples collected in June 2007 at Block 93 North were also used when contouring data in the vicinity of Block 94 North.
- Sample results denoted as "##-GZA" represent the data from the latest sampling round obtained by GZA GeoEnvironmental of New York as part of the work performed on the former Lever Brothers property (June 2007) and reported Supplemental Remedial Investigation Report and Remedial Action Workplan (GZA, 2007b). These data were used to assist in generating isoconcentration contour lines for each time-period.

#### Basemap Sources:

- Boundary and topographic survey of Block 95, Lot 1 and Block 93, Lots 1,2, and 3 performed by Vargo Associates in September 2005 and updated as recently as September 2006.
- Borough of Edgewater Tax Map - November, 1959
- Coal Tar Engineering Design Report (Environ, July 2005)
- Site Investigation Report, Part 4 (Langan, May 2004) for the former Lever Bros. Property.

0 80 ft. 160 ft.



GROUNDWATER ISOCONCENTRATION CONTOURS  
ARSENIC (Shallow Groundwater)

Quanta Resources Superfund Site  
Operable Unit 1  
Edgewater, New Jersey

June 23, 2008

FIGURE 5-14



Figure 6-1  
Conceptual Site Model for OU1  
Quanta Resources Site, Edgewater, New Jersey

